GEOLOGY OF BRUSHY CREEK QUADRANGLE
WILLIAMSON COUNTY, TEXAS

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(Signature of Supervising Professor)

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For the Graduate School

# GEOLOGY OF BRUSHY CREEK QUADRANGLE
# WILLIAMSON COUNTY, TEXAS

by

DICK E. ATCHISON, B.S.

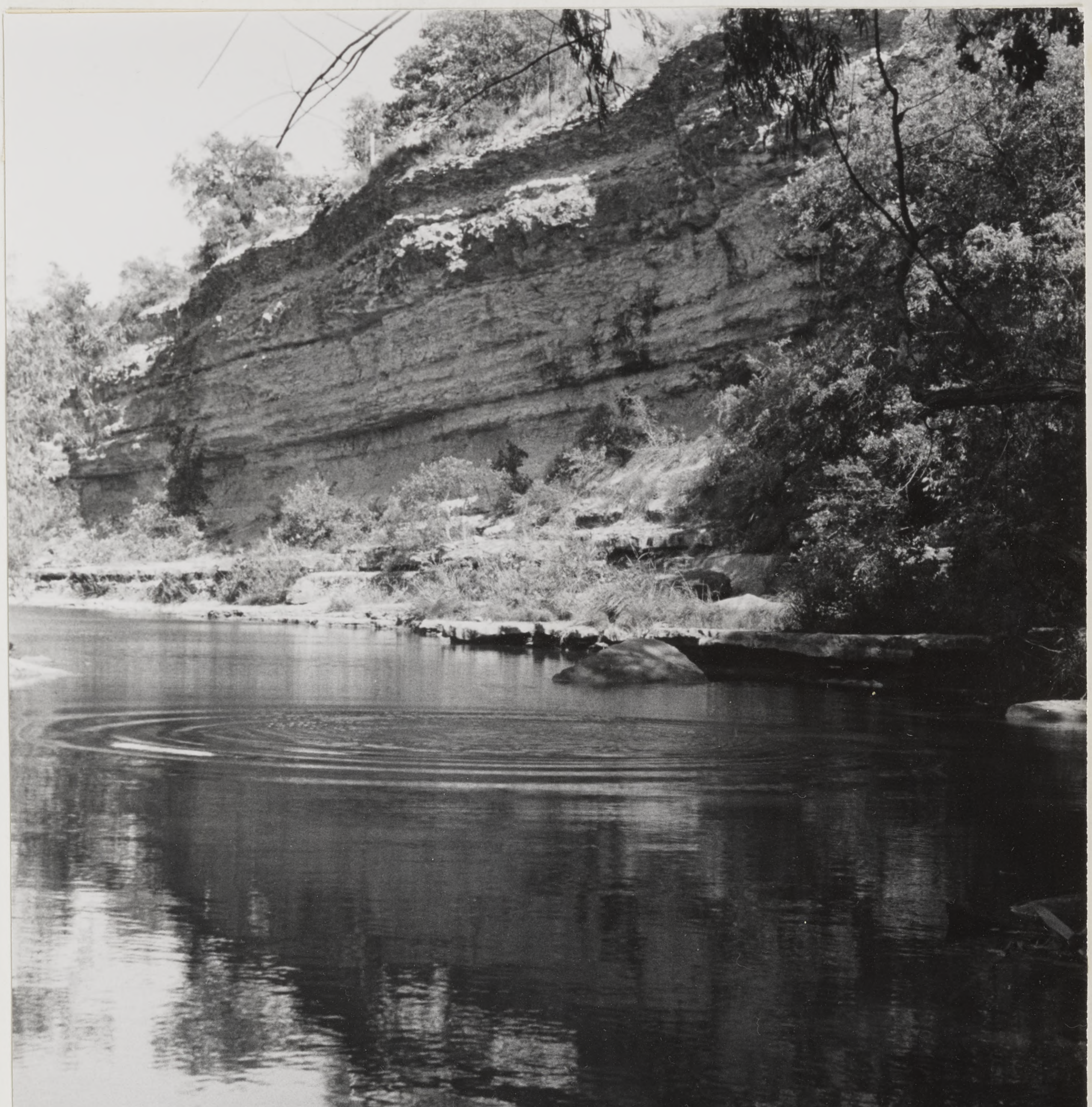
THESIS

Presented to the Faculty of the Graduate School of
The University of Texas in Partial Fulfillment
of the Requirements

For the Degree of
Master of Arts

THE UNIVERSITY OF TEXAS
August 30, 1954

F R O N T I S P I E C E



THE SOUTH BANK OF BRUSHY CREEK AT ROUND ROCK

The view is toward the east and downstream.

# A B S T R A C T

The exposed bedrock of Brushy Creek Quadrangle, Williamson County, Texas, is of Albian to Coniacian Age. In ascending order, the outcropping formations are Comanche Peak, Edwards, "Kiamichi", Georgetown, Del Rio, Buda, Pepper, Eagle Ford, and Austin. Three lithologic subdivisions of the Edwards are recognized, and five members of the Georgetown limestone are differentiated on the basis of lithology and fossil content. The structural relief results from normal strike faults breaching a Gulfward dipping homocline. En echelon faults of the Balcones Fault Zone bisect the area from north to south. Limestone and dolomite are quarried near Round Rock, but the backbone of the economy is agriculture.

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# I N T R O D U C T I O N

The inland margin of the Gulf Coastal Plain has been of intermittent interest to the petroleum geologist since the economic potentialities of faulted oil traps were first discovered. Whereas the boundary between the Belted Coastal Plain and the Grand Prairies is of a flexural nature in north Texas, it becomes faulted north of Georgetown in Williamson County. These faults, collectively called the Balcones Fault Zone, are <u>en echelon</u> and tend to increase in both length and throw toward the southwest. In the vicinity of San Antonio the strike swings more westwardly. Near Uvalde the fault zone diminishes along the northern edge of the Rio Grande Embayment. The area considered in this report is bisected from north to south by faults of the Balcones system. It is hoped that the results of this investigation may be of aid in future exploration along the Balcones Fault Zone.

<u>Location</u>.-- Brushy Creek Quadrangle (Figure 1) is in south central Williamson County, between latitudes 30° 30' and 30° 35' N., and longitudes 97° 40' and 97° 45' W. The city of Round Rock is located in the extreme southeastern corner, and Georgetown is four miles north of the northeastern corner. This five minute quadrangle encompasses approximately thirty square miles and was named for the principal stream draining the area.

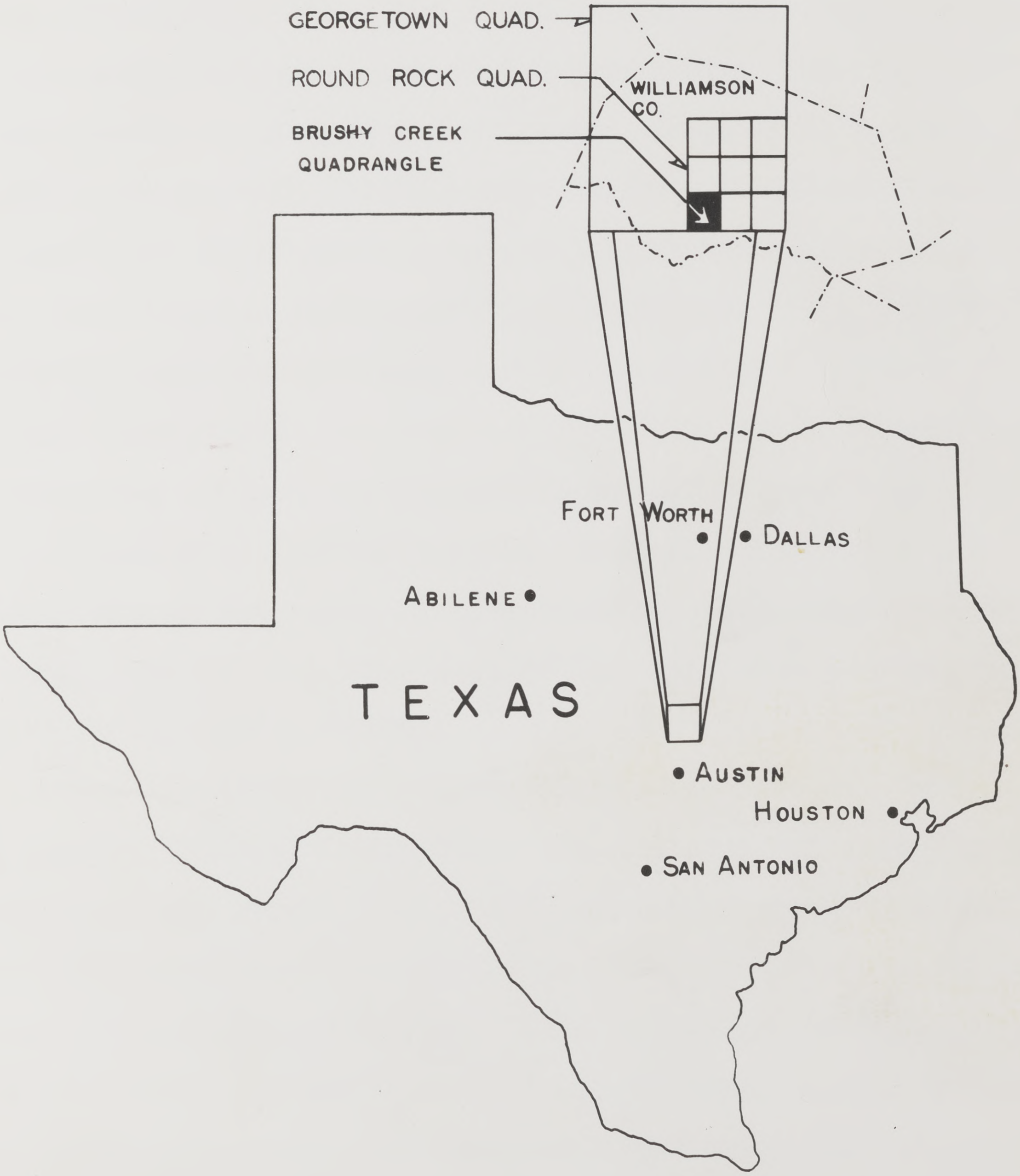



FIGURE 1.

Location of Brushy Creek Quadrangle.

Previous Work.-- The Washita Group and overlying Gulf Series in central Williamson County have been studied by many noted geologists. The first geologic investigation was an extended reconnaissance of the Georgetown, Del Rio, and Buda formations along the San Gabriel River by J. A. Taff (1893). R. T. Hill (1900) studied this general area from a geologic and physiographic aspect. The mineral resources were investigated in 1914 by W. B. Phillips. F. L. Whitney collected and studied fossils from the Georgetown formation (1925, unpublished) and later mapped along the Balcones Fault. Correlation between the Georgetown of central and north Texas was attempted in 1927 by Cuyler. Later, Adkins and Arick (1930) mapped the north Texas Georgetown equivalents in Bell County. The Del Rio clay east of the city of Georgetown was described by Adkins (1930).

More detailed work began in 1949 when Hazzard, Feray, et al. described the "Kiamichi" and adjacent rocks on Brushy Creek in Round Rock. Ward (1949) mapped an area immediately west of Georgetown. In 1950 Marks zoned the Austin chalk on a biostratigraphic basis, and Walls mapped the members of the Georgetown formation in Bell Gin Quadrangle. The Woodbine and Eagle Ford groups were described at Townes Mill on the San Gabriel River by Adkins and Lozo (1951). Zonation of the Austin chalk was continued by Gordon (1950), Tydlaska (1951), and Hartwig (1952). Young and Marks (1952) published the zonation of the Austin Chalk that was reaffirmed by Arrington

(1954) in Berry Creek Quadrangle northeast of Georgetown.

Purpose.-- In order to facilitate a minimal completeness to this general geological report, it was pertinent to include both stratigraphic and structural data. Equal consideration was also accorded to the economic exploitation. In short, the purpose was fourfold: to accurately record what, why, when, and of what value were the rocks in Brushy Creek Quadrangle. Fulfillment of this aim entailed stratigraphic descriptions, detail mapping of the Balcones Fault Zone (Plate 10), mapping structurally where indicated (Plate 8), and extending the zonation of the Georgetown formation (Adkins and Arick, 1930) southward from Bell County.

Measured sections and stratigraphic descriptions are included in Appendix I. The locations of fossil collecting localities and illustrative structural features are described in Appendix II and shown on Plate 10.

Methods.-- The usual field methods adaptable to a one-man party were used in obtaining data. Strikes and dips were determined with a Brunton compass and checked by descriptive geometry methods. Thicknesses were measured with a hand level and a 6-foot steel tape. An American Pauling altimeter was used in conjunction with the U.S.G.S. Topographic Map of Round Rock Quadrangle (1923-1925, revised 1949) in determining elevations. Excellent mosaic and stereoscopic aerial photographic coverage, generously donated by Edgar Tobin Aerial Surveys, Inc., lent both convenience and accuracy to the field mapping. Some limitations of the methods used were recognized prior to the field work and an effort was made to minimize errors by the repetition of measurements. The U.S.G.S. topographic map was enlarged to 1/20,000 and used as a base for the geologic and structural maps.

Physiography.-- The boundary between two great physiographic provinces crosses the quadrangle from north to south. The eastern two-fifths of the quadrangle is in the Blackland Prairies and Gulf Coastal Plain. The remainder is a southern extension of the Lampasas Cut Plain.

Numerous short, steep streams originate in the central part of the area and feed the surface run-off into Chandler and Onion branches, which are in turn drained to the east by Brushy Creek. The annual rainfall is a continental type and approximately 30 inches, but the irregularity of precipitation causes all the streams to flow intermittently. Atmospheric changes resulting from the location of the Balcones fault in relation to the Gulf of Mexico and the prevailing southeasterly winds have produced local floods in excess of 20 inches in 24 hours. This relationship compares mildly to the monsoonal conditions along the southern Himalaya Mountains. The area has an average low relative humidity and a temperate climate.

East of the fault zone the development of the deep chernozem and gentle dip slopes typical of the Blackland Prairies has been prohibited by the proximity of this area to the faults. Upland, "Uvalde", gravels cap many of the topographic highs, usually overlying bedrock of the less resistant stratigraphic units. Much of the area has also been covered by a thin veneer of more recent, unconsolidated float of chert cobbles. Regardless of the rocky surface, the soil yields a good harvest of cotton, corn, and other row crops. Member A of the Georgetown formation and the steep slopes of Del Rio marl are reserved for grazing.

The highest and lowest elevations are both east of the major faults. The highest (960+ feet) occurs at the top of Rabbit Hill, a remnant of an obsequent fault line scarp held up by hard Buda limestone and capped with a terrace of "Uvalde" gravel. The bed of Brushy Creek at the eastern boundary has the lowest elevation (680- feet).

West of the Balcones fault zone the terrain is rough and rocky. Small streams have dissected steep-sided valleys in the hard Edwards limestone. Many springs and seeps issue from bedding planes and minor faults. Travertine deposits and local consolidated gravels occur in creek beds (Figure 5). Many small caves and two larger caverns (Bat Cave and Steam Cave, about 1.5 miles north of the area, 2.5 miles southwest of Georgetown and 0.5 mile west of U. S. Highway 81) illustrate the effectiveness of chemical weathering in the Edwards limestone.

The native grassland has been drastically reduced by an overgrowth of cedar. The cedar shows a definite preference for the Edwards formation.

The thinness and frequent absence of topsoil on the Comanche Peak and Edwards limestone prohibit cultivation on a large scale, but the availability of ground water allows the prosperous industry of raising cattle, sheep and goats.

Acknowledgements.-- The farmers and ranchers residing in Brushy Creek Quadrangle, without exception, openhandedly gave access to their lands and thus allowed an unrestricted compilation of field data. Aerial photographic coverage was generously donated by Edgar Tobin Aerial Surveys, Inc. Robert N. Arrington photographed the fossils (Plates 1-7) and alternated as companion, colleague, and critic. Many worthwhile suggestions pertaining to the presentation of data were contributed by committee members, Stephen E. Clabaugh and Robert L. Folk. To each benefactor for every consideration the writer expresses sincere gratitude. Especial thanks for his assistance, criticism, and advice are extended to Keith Young, who served as Supervising Professor.

## S T R A T I G R A P H Y

### CRETACEOUS SYSTEM

Subsurface information indicates the presence of Paleozoic rocks of the Ouachita belt folded below the Wichita Paleoplain in this area (Sellards, 1933, p. 128; Adkins, 1933, p. 260). The portion of geologic history recorded by rocks outcropping in Brushy Creek Quadrangle begins with the Comanche Peak formation of Middle-Albian age. The two Series in the Cretaceous System of central Texas are both represented (Figure 2). The older, Comanche Series, is composed of the Trinity, Fredericksburg, and Washita groups. The massive Trinity limestones and lower Fredericksburg limestones and shales outcrop to the west and occur only in the subsurface in this quadrangle. The younger Series, Gulf, includes the Woodbine, Eagle Ford, and Austin groups in this area, plus the Taylor and Navarro groups outcropping a few miles to the east. The lower <u>Inoceramus subquadratus</u> subzone (Arrington, 1954) is the youngest Cretaceous rock unit found in the area.

### Fredericksburg Group

Originally named and misplaced in the section by Roemer, the Fredericksburg group was later classified by R. T. Hill (Adkins, 1933, p. 322). The group includes the Walnut, Comanche Peak, Edwards, and Kiamichi formations. The Walnut

DIAGRAMATIC GEOLOGICAL SECTION OF BRUSHY CREEK QUADRANGLE

| | LOCAL SERIES | EUROPEAN SUBSTAGE | LOCAL GROUP | FORMATION | THICKNESS | MEASURED SECTION | LITHOLOGY | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|
| UPPER CRETACEOUS | GULF SERIES | CONIACIAN | AUSTIN | Austin | 25′ | 7 | | Limestone, medium hard, massive bedded, nodular, with alternating beds of cream, soft to friable, calcareous shale. |
| UPPER CRETACEOUS | GULF SERIES | TURONIAN | EAGLE FORD | South Bosque | 20′ | 6 | | Shale, dark gray, soft, friable, laminated. |
| UPPER CRETACEOUS | GULF SERIES | TURONIAN / CENOMANIAN | EAGLE FORD | Lake Waco | 25′ | 6 | | Limestone, tan to gray, hard, thin-bedded, sandy, with beds of light brown to gray, soft, thin-bedded shale. |
| UPPER CRETACEOUS | GULF SERIES | CENOMANIAN | WOODBINE | Pepper | 10′ | 6, B. | | Shale, dark blue to black, slightly indurated, fissle, gypsiferous. |
| UPPER CRETACEOUS | COMANCHE SERIES | CENOMANIAN | WASHITA | Buda | 30′ | A., 5 | | Limestone, light brown, massive bedded, honey-combed, crystalline. |
| UPPER CRETACEOUS | COMANCHE SERIES | CENOMANIAN | WASHITA | Del Rio | 70′ | 4 | | Shale, greenish gray, soft, laminated, gypsiferous. |
| LOWER CRETACEOUS | COMANCHE SERIES | ALBIAN | WASHITA | Georgetown | 85′ | 3, 2, 1C | | Limestone, light gray to white, hard, chalky, nodular, thin to massive bedded, with alternating light gray, soft, laminated, calcareous shale. |
| LOWER CRETACEOUS | COMANCHE SERIES | ALBIAN | FREDERICKSBURG | "Kiamichi" | 5′ | 2, 1C, 8 | | Limestone, light brown to white, hard, indistinctive bedded, argillaceous, with some marl. |
| LOWER CRETACEOUS | COMANCHE SERIES | ALBIAN | FREDERICKSBURG | Edwards | 210′ | 1B, 1A | | Limestone, light brown to white, very hard, thin to massive bedded, crystalline. |
| LOWER CRETACEOUS | COMANCHE SERIES | ALBIAN | FREDERICKSBURG | Comanche Peak | 25′ | 1A | | Limestone, light gray to white, indurated, medium bedded, interbedded with light gray argillaceous shale. |

Figure 2.

and lower Comanche Peak formations are excellently exposed along the San Gabriel Rivers west of Georgetown, but only the uppermost few feet of Comanche Peak are exposed in this area in the bed of Brushy Creek near the west boundary. Massive Mollusca reefs are typical of the Fredericksburg limestones in central Texas.

Stratigraphers have not established a universally acceptable upper boundary for the Fredericksburg group. With full cognizance that the "Kiamichi" in Brushy Creek Quadrangle lithologically resembles the overlying basal beds of Member A of the Georgetown formation, for structural and paleontological reasons the writer includes "Kiamichi" in the Fredericksburg group.

## Comanche Peak Limestone

The Comanche Peak was correctly placed below the Edwards limestone, incorrectly placed above the Austin chalk, and named for the type locality in Hood County by Shumard in 1860. The Comanche Peak is considered to be lithically continuous with the Goodland formation in north Texas (Adkins, 1933, p. 334). The lower and upper contacts are reportedly conformable. The latter is a 10-foot transition zone included in the Edwards limestone in the area under consideration.

The only outcrop of Comanche Peak limestone in Brushy Creek Quadrangle occurs near the southwestern corner. The limestone is white, medium hard, massive, nodular, and weathers to a dark gray color (Measured section 1A, Figure 9). The limestone nodules are elongated horizontally, angular, and exhibit a patent conchoidol fracture in vertical exposures.

Large gastropods and pelecypods occur in abundance throughout the limestone. A few echinoids, Exogyra texana (Roemer), and one individual of Engonoceras sp. were collected by the writer from Brushy Creek. A thin marl stratum occurring approximately the same distance (25 feet) below the Edwards limestone along the North San Gabriel River yielded numerous individuals of Exogyra texana, Enallaster sp., and Engonoceras sp., and one Oxytropidoceras sp. aff. bravoense.

Fossils collected by the writer from the upper part of the Comanche Peak limestone are:

Mollusca

Pelecypoda

Exogyra texana (Roemer) (UT, 10496)

Gryphaea sp.

Pecten sp.

Protocardia texana (Conrad)

Cyprimeria sp.

Pinna sp.

Cephalopoda

Engonoceras sp. (UT, 10492)

Oxytropidoceras sp. aff. bravoense (Böse) (UT, 10491)

Gastropoda

*Tylostoma* sp.

*Turritella* sp.

*Alipes* sp.

Echinoderma

*Enallaster* sp. (UT, 10494)

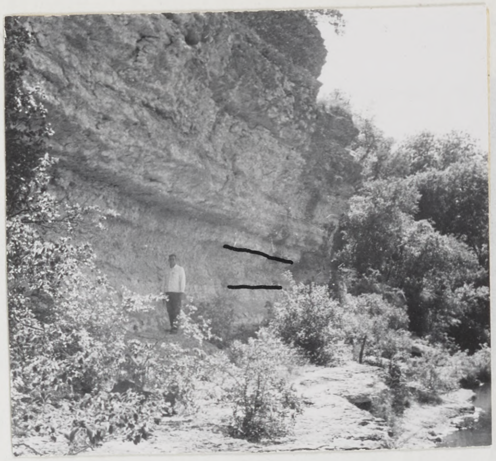
## Edwards Limestone

Lithically the Edwards limestone (Hill and Vaughan, 1899) outcropping in Brushy Creek Quadrangle resembles the type section on Barton Creek near Austin. The massive limestone beds, bands of chert nodules, and thick rudistid biostromes (Cumings, 1932) comprise approximately half of both the outcrop area and stratigraphic section exposed in Brushy Creek Quadrangle. Brushy Creek and smaller tributaries have dissected steep-sided valleys in this thick section of relatively pure limestone. Numerous small caves, seeps, springs, and travertine deposits attest the vulnerability of the Edwards limestone to chemical weathering processes. Mechanical weathering processes have permitted the accumulation of only an ephemeral residual soil. The rough and rocky terrain supports a thick overgrowth of cedar and is utilized exclusively for grazing.

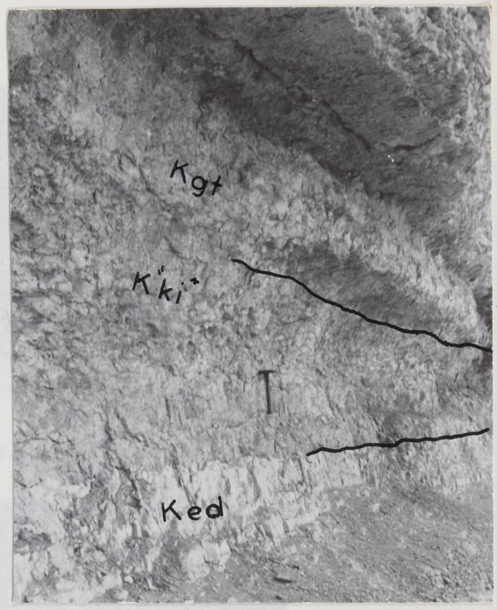
Hill (1901) reported the Edwards to be 230 feet thick along Brushy Creek. The writer calculated a minimum thickness of 210 feet indicated by the width of outcrop and dip.

The tangent vector method, advocated by Whitney, was used in all calculations because of the low dip. Zones of minor faulting cross Brushy Creek in two places, but the resulting loss of section is estimated not to exceed 20 feet.

The Edwards limestone conformably overlies the Comanche Peak limestone and unconformably underlies rocks of the "Kiamichi" and Georgetown formations in Brushy Creek Quadrangle. The transition from Comanche Peak to Edwards is gradational near Georgetown, but appears to be interfingering in Brushy Creek. Bore holes in a thin sublithographic limestone stratum of Edwards are filled with "Kiamichi" limestone on Lake Creek at Round Rock (Measured section 8, Locality 11). On Brushy Creek at Round Rock (Locality 2), a massive-bedded limestone containing scattered individuals of Toucasia underlies the "Kiamichi" limestone. The upper part of this bed contains burrows which are filled with overlying "Kiamichi", and pebbles of this bed are reworked into the basal bed of the "Kiamichi". Near Chandler Branch four miles north of Round Rock, Member A of the Georgetown overlies a massive Edwards Toucasia reef. The bedding in the Edwards limestone is consistent in Brushy Creek Quadrangle. Therefore the variation in lithology at the top of the Edwards limestone in the writer's opinion is caused by pre-"Kiamichi" and pre-Georgetown erosion rather than facies changes. Unconformability of the upper contact is evident by faunal and lithologic contrasts (Figures 3 and 4), and a slight regional angularity is indicated.

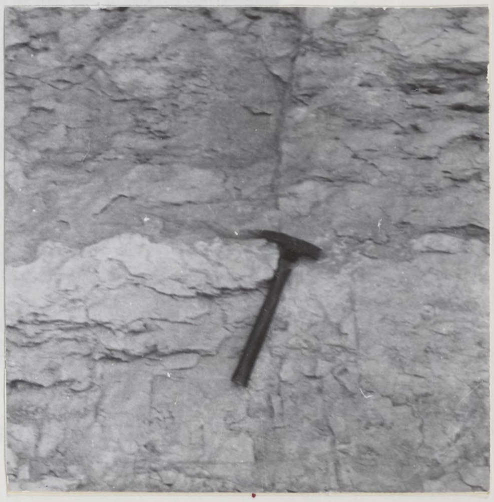


a.




b.

c.



d.

Figure 3.

The south bank of Brushy Creek at Round Rock (locality 2).

a. Edwards, "Kiamichi", and Georgetown formations, the camera points west in this view.
b. The Edwards-"Kiamichi" and "Kiamichi"-Georgetown contacts at the same location.
c. Oxytropidoceras sp. in the "Kiamichi", same location.
d. Close-up view, Edwards-"Kiamichi" contact, same location.

a.

b.

Figure 4.

The Edwards-"Kiamichi" contact up dip from Figure 3.

a. The hammer marks the contact near the railroad crossing on Farm Road 620 in the western edge of Round Rock, 0.5 mile west of locality 2.

b. The contact 1 mile up Lake Creek from the railroad bridge at Round Rock, 0.5 mile southwest of locality 2.

This writer made no attempt to subdivide or zone the Edwards limestone, but to facilitate a more precise stratigraphic orientation the upper 50 feet are herein referred to as the upper belt, next lower 80 feet as the middle belt, and the remaining 100+ feet as the lower belt (Measured section 1, Figure 9).

Light gray to white, hard, massive, biostromal limestone beds are characteristic of the lower belt. The lower beds of the lower belt consist of white, hard, massive, honeycombed limestone. A thick rudistid reef occurs near the middle of the lower belt. The upper part of the lower belt contains dolomitic strata, sublithographic limestone, thick illuviated pelecypod biostromes, and light brown to blue-gray chert nodules. Excellent exposures of the lower belt occur at Localities 1 and 12. Specific localities are listed and described in Appendix I and shown on Plate 10.

The middle belt is characterized by beds of thin chert nodules, crystallized calcite, rare pulverulites, and medium-bedded oolitic and miliolid limestone. The chert nodules average 0.2 foot in thickness and the smooth rounded, rolling top and bottom surfaces may encompass several square feet. A thin peripheral layer is composed of light cream to white, sublithographic limestone. The chert appears to be black to dark blue and frequently banded parallel to the bedding, but thin, freshly broken slivers are light gray to white and translucent. The upper part of the middle belt is exposed in a quarry one mile west of Round Rock (Locality 13).

The upper belt contains thick caprinid and rudistid biostromes, thin beds of lithographic limestone, and stringers of calcareous shale. A thin argillaceous bed occurring approximately 25 feet below the Georgetown formation along Brushy Creek contains profuse Holectypus planatus (Locality 15). The upper 15 or 20 feet are well exposed in Brushy Creek at Round Rock; a less defined but thicker section occurs at Locality 16 (Measured section 1C, Figure 9).

Several species of high spired gastropods were collected from the Edwards formation. Fossils collected by this writer include:

Mollusca

Pelecypoda

Chondrodonta sp.

Eoradiolites sp.

Toucasia sp.

Neithea sp.

abundant caprinids

Gastropoda

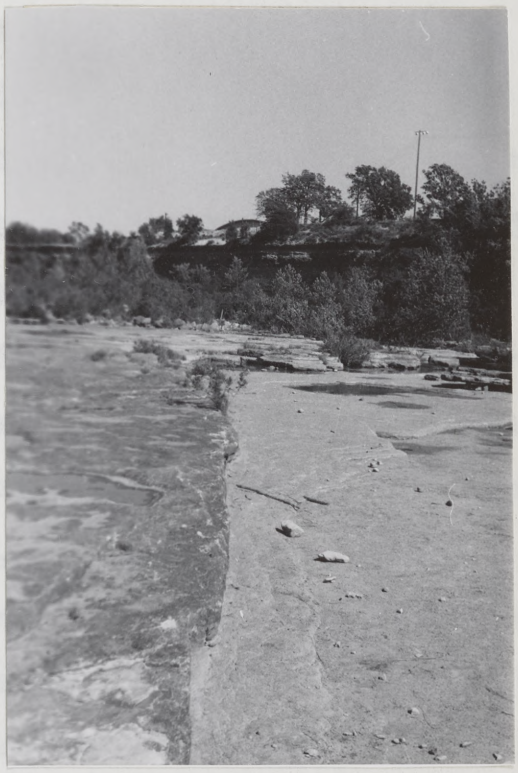
Turritella sp.

Ceritella sp.

Echinoderma

Holectypus planatus (Roemer) (UT, 10502)

a.



b.

c.

Figure 5.

The Edwards limestone along Brushy Creek.

a. Strata of dolomite in the lower belt of the Edwards dipping 15° N. 30° W. near the south end of Onion Fault at locality 12.
b. Joints in the bed of Brushy Creek at Round Rock striking N. 68° W. The undercut bank in the background is locality 2.
c. One of the numerous small travertine deposits in the middle belt of the Edwards limestone along Brushy Creek.

## "Kiamichi" Limestone

The fauna of the uppermost 4.3 feet of Fredericksburg "age" rocks exposed in Brushy Creek at Round Rock correlates with the Kiamichi fauna in north Texas (Hazzard, Feray, et al., 1949). Neritic deposition, characteristic of the Kiamichi formation (Adkins, 1933, p. 349), is also indicated at Round Rock, but the fossiliferous limestone facies differs from the clay and limestone beds typical of north Texas. Taff (1892) first reported the isolated outcrop herein referred to as "Kiamichi". The nearest Kiamichi outcrop continuous with north Texas is approximately 50 miles north at Whitson, Coryell County (Adkins, 1933, p. 351).

The "Kiamichi" at Round Rock consists of two limestone strata (Measured section 2, Figure 10). The contact with the underlying Edwards formation shows filled bore holes and is unconformable (Figure 4). The basal stratum is 3.1 feet of light brown, medium hard, indistinctly-bedded, argillaceous, limestone. *Oxytropidoceras* sp. aff. *supani* (Lasswitz) occurs in this bed. A manifest color change marks the undulating boundary between the lower stratum and the upper stratum of the "Kiamichi". The upper bed consists of 1.2 feet of light gray, medium hard, indistinctively-bedded, argillaceous, fossiliferous limestone. *Oxytropidoceras belknapi* (Marcou), *Enallaster* sp., *Exogyra* sp., and abundant *Gryphaea* sp. were collected from this bed. The upper contact with the basal bed of the Georgetown formation is indistinct and has been reported to be transitional (Hazzard, Feray et al., 1949).

The "Kiamichi" formation is also exposed in Lake Creek and Onion Creek at Localities 11 and 14 respectively. One well preserved individual of "Eopervinquieria" n. sp. 1 (Plate 1) was found in the lower "Kiamichi" at locality 11 (Measured section 8, Figure 16). The Georgetown formation unconformably overlies an Edwards Toucasia reef on Chandler Branch west of Highway 81 in the northern part of Brushy Creek Quadrangle, the "Kiamichi" being absent at this locality.

Fossils collected from the "Kiamichi" formation by this writer include:

Mollusca

Pelecypoda

Exogyra sp. (UT, 10504)

Gryphaea sp. cf. navia (Hall)

Pecten sp.

Cephlapoda

Oxytropidoceras belknapi (Marcou) (UT, 10505)

Oxytropidoceras aff. bravoense (Böse)(UT,10506)

Oxytropidoceras sp. cf. supani (Lasswitz) (UT, 10549)

"Eopervinquieria" n. sp. 1 (this paper) (UT, 10530)

Echinoderma

Enallaster sp. (UT, 10503)

## Washita Group

Washita was originally intended by B. F. Shumard as the name of the Georgetown formation (Adkins, 1933, p. 360), but usage prevailed and the Washita has been redefined as a group (Hill, 1887, p. 298). Included are the Georgetown, Del Rio, and Buda formations of Brushy Creek Quadrangle.

The basal contact, Fredericksburg-Washita, is unconformable in Brushy Creek Quadrangle. The absence of the "Kiamichi" four miles north of the area indicates that the unconformity is angular, and the discordance is very small. All interformational contacts within the Washita group appear to be conformable. Exposures of the Del Rio-Buda contact excellently illustrate gradational transition from a shale facies into limestone.

The upper boundary between the Buda formation and the Woodbine group is unconformable but concordant (Adkins, 1933, p. 361). Woodbine and Eagle Ford residual soils obscure the exact contact in Brushy Creek Quadrangle, and the Buda-Woodbine contact was mapped by a change in slope.

### Georgetown Limestone

The Georgetown formation was first zoned in Williamson County by Walls (1950), who employed criteria established in Bell County by Adkins and Arick (1930). The members were defined on the basis of lithology, and guide fossils for each member were listed. The reliability of this zonation has been affirmed by Arrington (1954) and reaffirmed by the writer.

Member A consists of 23 feet of thick-bedded, nodular limestone containing Idiohamites fremonti (Marcou), Desmoceras brazoense (Shumard), and Mortoniceras aff. trinodosum (Böse). Member B consists of 25 feet of interbedded, chalky, argillaceous limestone and light gray to buff shale, predominately shale, in Brushy Creek Quadrangle. Characteristic fossils include Prohysteroceras austinense (Roemer), Mortoniceras (Leonites) maximum (Lasswitz), and Exogyra walkeri (White).

Member C is a 5 foot Gryphaea washitaensis (Hill) agglomerate with a matrix of brown to buff marl. Member D consists of 10 feet of interbedded, thin, soft, chalky limestone and light gray to buff marl. Guide fossils are Mortoniceras wintoni (Adkins) and Mortoniceras n. sp. 3 (Arrington). Member E consists of 20 feet of light gray, hard, crystalline, thin-bedded limestone containing Turrilites brazoensis (Roemer) in the upper part, Kingena wacoensis (Roemer) in abundance throughout, and Mortoniceras n. sp. 4 (Arrington) in the lower beds.

The correlation of these members with their north Texas equivalents is illusory. Paleontologically the Desmoceras brazoense zone near the bottom of Member A correlates with the same zone in the Duck Creek formation in Grayson County. The Turrilites brazoensis zone in Member E is correlative with the upper part of the North Texas Mainstreet formation. Thus the lower and upper formational boundaries are approximately equivalent. The relationship between the intervening members (B, C, and D) and the Fort Worth, Denton, Weno, and Pawpaw formations is not so discernible, although Member C and the top of the Denton seemingly correlate. Adkins and Arick (1930) state that the Pawpaw thins southward and is absent in Bell County.

<u>Member A</u>.-- Member A is best exposed in this area near the southeastern corner in Brushy Creek and vicinity. This outcrop is about one mile wide and underlies most of Round Rock. The residual soil is a rocky chernozem. It resembles the thinner Edwards soil, but it supports a much less profuse overgrowth of cedar. Both are very rocky and seldom cultivated.

Both lower and upper contacts are exposed in Brushy Creek 100 yards upstream from the U. S. Highway 81 bridge (Figure 3). The lower contact is an angular unconformity regionally; the upper contact appears to be a conformable transition by gradation. Between these contacts are 23 feet of light gray, hard to medium, slightly chalky, thick-bedded, nodular, fossiliferous limestone; interbedded with stringers of gray to buff, soft, laminated, very calcareous, fossiliferous shale (Measured section 2, Figure 10).

The darker color of the lowermost bed in Member A is distinguished from the lighter colored underlying "Kiamichi" at Round Rock. The lower six feet consists of two beds of dark gray to light brown, arenaceous limestone containing abundant Gryphaea washitaensis. A thin (0.3 foot) bed of marl separates these beds, and upon weathering allows the upper bed to form a prominent ledge. One individual of "Elobiceras" sp. (Plate 1) was collected in Lake Creek from this level.

The next highest ledge is formed by five feet of nodular limestone. Idiohamites fremonti occurs at this level in Brushy Creek, and according to Hazzard, Feray, et al., (1949) Prohysteroceras sp. is also present. This is approximately the same stratigraphic level that contains abundant Desmoceras brazoense in both San Gabriel River beds at Georgetown, and D. brazoense and "Eopervinquieria" n. sp. 2 on the west side of Highway 81 about 0.7 mile north of the Chandler Branch bridge.

Overlying the Idiohamites fremonti and Desmoceras brazoense zone and separated by 0.4 foot of marl is a thick (8 feet), massive-bedded limestone containing numerous Mortoniceras n. sp. 1 (Arrington) aff. trinodosum (Böse) and other mortonicerids.

The highest ledge-former in Member A is a massive-bedded, 3 feet thick, light gray limestone from which several species of Mortoniceras, including M. n. sp. 2 (Arrington) aff. trinodosum were collected (Plate 2).

Fossils collected by the writer from Member A include:

Mollusca

Pelecypoda

<u>Gryphaea</u> <u>washitaensis</u> (Hill)

Cephalopoda

<u>Desmoceras</u> aff. <u>brazoense</u> (Shumard) (UT, 10508)

<u>Idiohamites</u> <u>fremonti</u> (Marcou) (UT, 10509)

<u>Mortoniceras</u> (<u>Leonites</u>) <u>maximus</u> (Lasswitz) (UT, 10519)

<u>M</u>. n. sp. 1 (Arrington) aff. <u>trinodosum</u> (Böse) (UT, 10513)

<u>M</u>. n. sp. 2 (Arrington) aff. <u>trinodosum</u> (Böse) (UT, 10512)

"<u>Eopervinquieria</u>" n. sp. 2 (this paper) (UT, 10544)

<u>Member</u> <u>B</u>.-- This unit outcrops extensively in the eastern part of Brushy Creek Quadrangle. Between Chandler and Onion Branches the outcrop exceeds one mile in width. The residual soil is a more typical example of the pedocal soil series than the thin Member A and Edwards soils. The black to reddish brown topsoil (A-zone) is usually in cultivation, and it varies from 0.5 foot to 2 feet thick. The underlying thick caliche zone is invariably present.

Along Chandler Branch east of Highway 81 the lower and upper contacts are exposed. Both are conformable, concordant, and gradational in this area. Member B consists of 25 feet of light gray to white, indurated to hard, thin-bedded, nodular, chalky, fossiliferous limestone beds, interbedded with gray to buff, soft to friable, very calcareous shale (Measured section 3, Plate 11).

Shale dominates the lower 10 feet with a sparse spacing of thin (0.5 to 1.0 foot) nodular, chalky limestone beds.

Prohysteroceras austinense (Roemer) is abundant in this part but ranges throughout the entire member as does Mortoniceras (Leonites) maximum (Lasswitz). The limestone strata thicken to 1 and 2 feet and the shale beds are reduced to thin 0.5 foot stringers in the upper 15 feet. Leonites n. sp. 1 (Arrington) was found to occur in considerable number along with Leonites n. sp. 2 and L. n. sp. 3 consistently between 5 and 15 feet below the base of Member C (Plates 5, 6, and 7).

A concentration of Hemiaster elegans (Shumard) persists in the upper 5 feet. Near the new highway cloverleaf south of Belton in Bell County abundant specimens of this large echinoid were found in approximately the same stratigraphic position. Scattered specimens of H. elegans were collected throughout Members A, B, C, and D; but the abundance in the upper 5 feet of Member B constitutes an epibole. Immediately below the upper contact a thin (0.5 foot) Kingena wacoensis bed initiates the process of gradation into Member C.

The varied fauna of Member B is represented by the following fossils collected by the writer:

Mollusca

Pelecypoda

Exogyra walkeri (White)

Gryphaea washitaensis (Hill)

Pecten sp.

Cephalopoda

Leonites n. sp. 1 (Arrington) (UT, 10520)

*Leonites* n. sp. 2 (this paper) (UT, 10523)

*Leonites* n. sp. 3 (this paper) (UT, 10521)

*Prohysteroceras austinense* (Roemer) (UT, 10518)

*Mortoniceras* (*Leonites*) *maximum* (Lasswitz)

Echinoderma

*Hemiaster elegans* (Shumard) (UT, 10540)

Brachiopoda

*Kingena wacoensis* (Roemer)

*Member C*.-- This member has a very limited area of outcrop in Brushy Creek Quadrangle. It is a consistent *Gryphaea washitaensis* calcirudite 5 feet thick. The narrow outcrop compelled the writer to map Member C with Member D. Thus, the contact line on the bedrock map (Plate 10) between Members B and D represents the outcrop area of Member C. Advantage was taken of this narrow outcrop, consistent thickness, distinctiveness, and numerous exposures; marking the approximate middle of the Georgetown, this member was deemed the logical horizon to contour structurally.

The soil is indistinguishable from that of adjacent Members B and D, except for rarely encountered areas of thin topsoil in which abundant *Gryphaea* shells are exposed. The lower and upper contacts of Member C are marked by an abrupt decrease in the number of *G. washitaensis* fossils (Figure 6). The matrix consists of bluish-gray to white, soft to indurated, calcareous shale, often weathered into hard caliche nodules (Measured section 3, Figure 11).

a.

b.

Figure 6.

a. A south view of the soil profile of Georgetown Member D at locality 3.
b. The hammer marks the contact between Member B and Member C of the Georgetown limestone. This is a south view at locality 3.

Arrington (1954) collected Leonites n. sp. 1 from Member C in Berry Creek Quadrangle, but no ammonites were found in this member in the area mapped by the writer. The fauna consists largely of G. washitaensis, but the following fossils were collected by the writer:

Mollusca

Pelecypoda

Gryphaea washitaensis (Hill)

Neithea texana (Roemer)

Exogyra walkeri (White)

Cephalopoda

Cymatoceras sp.

Brachiopoda

Kingena wacoensis (Roemer)

Echinoderma

Hemiaster elegans (Shumard)

Leiocidaris sp. (plates and spines)

Member D.-- Along the ridge line separating the Chandler Branch watershed from the area drained by Onion Branch is the largest outcrop of Member D in Brushy Creek Quadrangle. This outcrop averages 0.3 mile in width, and good exposures may be seen along Highway 81. Measured section 3 (Figure 11) includes another outcrop of Member D along the north bank of Chandler Branch. The fertile soil resembles the soils of Members B and C (Figure 6); all of which yield a good harvest of cotton, corn and row feeds.

Both lower and upper contacts are gradational, but the transition into the hard, crystalline, basal limestone bed of Member E is very abrupt. Both contacts are well exposed along Chandler Branch. Member D is 10 to 12 feet thick in this area and consists of light gray to buff, soft, crumbly, calcareous shale beds with thin (0.3 to 1.0 foot) strata of light gray to white, soft, nodular, chalky limestone containing Kingena wacoensis (Measured section 3, Locality 3).

Numerous Mortoniceras n. sp. 3 (Arrington) were collected and appear to be restricted to this member in Williamson County (Plate 3). Kingena wacoensis occurs profusely in the limestone stringers, and infrequent Exogyra walkeri and Hemiaster sp. were found in the shale beds. Although the fauna of Member D was limited in kind and number, the following fossils were collected by this writer:

Mollusca

Pelecypoda

Exogyra walkeri (White)

Cephlapoda

Mortoniceras n. sp. 3 (Arrington) (UT, 10528)

Paracymatoceras sp.

Brachiopoda

Kingena wacoensis (Roemer)

Echinoderma

Hemiaster sp.

Member E.-- A low cuesta trending N. $60^{\circ}$ W., and parallel to the north bank of Chandler Branch is held up by Member E. The width of this outcrop is restricted to 0.2 mile by the slightly steepened inface and a Del Rio outlier on the dip slope. On McAdams Farm (Locality 10) an outlier of Member E capped with Del Rio is isolated against the Chandler fault. The Martinez farmhouse on Highway 81, 0.5 mile south of the northern boundary, is on a similar outlier in the lower part of Member E. The upper part is exposed along the east fork of Chandler Branch on the downthrown side of Three-Mile Fault (Plate 10).

The topsoil is thicker (2-4 feet) and blacker than the soils on the other members of the Georgetown formation. The annual rainfall in excess of 30 inches has influenced its development into a mature chernozem.

The lower contact, an abrupt gradation, was most obvious at Locality 3. The lower contact was reported to be unconformable in north Texas by Stephenson (1929). Member E consists of 20 feet of light gray, hard, crystalline, nodular, fossiliferous limestone, with thin (1.0 foot) beds of light gray to buff, soft, laminated, calcareous shale interbeds in the upper 4 feet.

Lower and upper contacts are poorly exposed at Localities 3 and 10, however, interfingering into the overlying Del Rio clay is more clearly exposed at Locality 8.

> An important part of the Main Street is the upper few feet, which form the "transition zone" (sic) to the overlying Grayson. (Adkins, 1933, p. 384).

In central Texas alternating beds of marly limestone and marl containing guide fossils of both the Georgetown formation and the Del Rio clay, Kingena wacoensis, Turrilites brazoensis, and Exogyra arietina respectively (Adkins, 1933, p. 385) compose the "transition zone", and substantiate the further classification of interfingering (Figure 7).

Mortoniceras n. sp. 4 (Arrington) was found to occur in the lower part of Member E in Brushy Creek Quadrangle (Plate 4). Arrington (1954) reported this species from the same stratigraphic level north of Georgetown, and Young (personal communication) verifies this zone in Travis County at Austin.

The occurrence of Turrilites brazoensis correlates the upper part of the Georgetown formation in this area to the original Washita formation in southern Oklahoma (Shumard, 1860), the Mainstreet formation in Grayson County (Hill, 1894), the Mainstreet equivalent in Bell County (Adkins and Arick, 1930), and the top of the Georgetown formation at Austin. Profuse Exogyra arietina, predominately a juvenile form, and Kingena wacoensis occur in the upper 4 feet of transitional beds. Representatives of the Member E fauna collected by the writer are:

a.

b.

Figure 7.

a. A southwest view of the transition zone in the top of Georgetown Member E at locality 8.
b. A west view of the small folds in the upper part of the lower Inoceramus subquadratus (Schluter) subzone of the Austin chalk at locality 7.

Mollusca

Pelecypoda

<u>Exogyra arietina</u> (Roemer)

Cephlapoda

<u>Mortoniceras</u> n. sp. 4 (Arrington) (UT, 10522)

<u>Turrilites brazoensis</u> (Roemer)

<u>Paracymatoceras</u> sp.

hamitid sp. (UT, 10539)

Brachiopoda

<u>Kingena wacoensis</u> (Roemer)

## <u>Del Rio Clay</u>

Inevitable mistakes in early correlations of this formation resulted in a wide selection of names. Notwithstanding the priority of the name Grayson by Cragin (1895) for the type section at Denison, Grayson County; to the adherents of Hill and Vaughn (1898) this formation is still known as the Del Rio for the type section near Del Rio. The writer uses the south Texas terminology because lithologic, structural, and geographic comparisons indicate greater similarity to the southern type section at Loma de la Cruz Butte, Val Verde County.

Pyritic micromorphs, pyrite, and gypsum are usually associated with the central and south Texas outcrops. South of Georgetown, Williamson County, the Del Rio conformably underlies the Buda formation. From Georgetown to near Waco, McLennan County, the Buda occurs intermittently (Adkins, 1924; Adkins and Arick, 1930; Arrington, 1954) and farther north, the Grayson (Del Rio) formation unconformably contacts the overlying Woodbine group (Adkins, 1933, p. 387). The steep slopes of the Del Rio outcrop in Brushy Creek Quadrangle are topographically and florally more akin to the buttes and lowlands of Val Verde County than the open, rolling prairies of north Texas. Thus, the proximity to the Balcones Fault and Edwards Plateau closely relates the central and south Texas Del Rio outcrops.

Del Rio clay is exposed on the steep sides of Rabbit Hill in the northeastern corner of Brushy Creek Quadrangle. This outcrop is approximately 0.4 mile wide. A similar outcrop is exposed on the inface of the Buda cuesta south of Lake Creek near Round Rock. Two outliers cap topographic highs in the east central part of the area on both sides of Chandler Branch. The black, plastic, clayey soil on the outliers and around the bottom of the steep slopes is cultivated, but it grades upward into thinner light greenish-brown soil that is usually reserved for grazing. Mesquite and prickly pear are native to the Del Rio slopes.

The lower transitional contact zone of alternating limestone and shale was included in the Georgetown formation. The top of the uppermost limestone stringer was selected as the base of the Del Rio by the writer. The upper contact is a gradational transition from marl into hard, dense limestone characteristic of the Buda formation. The zone of gradation is approximately 2 feet thick and was all included in the Del Rio clay.

On Hawkins Farm (Locality 4) there is a total thickness of 70 feet (Measured section 4, Figure 12). The light greenish-grey, soft, friable, laminated, gypsiferous shale contains thin, indurated strata of Exogyra arietina agglomerate in a calcareous matrix. The matrix is more arenaceous in a narrow (10 feet) zone 10 feet below the upper contact. The arenaceous zone may be a lateral equivalent of the nodular lower Buda limestone which is absent at this locality. The lower Buda is present in the southern part of the area but faults prohibited a comparison of total thicknesses of Del Rio. Exogyra arietina and Gryphaea graysonana abound throughout the formation, but the latter is prevalent in the middle third of the section.

Zones of pyritic micromorphs were found near the middle of both the upper and lower thirds at Locality 4. The pyritic "dwarfs" include individuals of Turrilites sp., Submantelliceras sp., Exogyra arietina, and other molluscans. Representatives of the Del Rio fauna collected by the writer include:

Mollusca

Pelecypoda

Exogyra arietina (Roemer)

Gryphaea graysonana (Stanton) (UT, 10535)

Pecten sp.

Cephalopoda

<u>Turrilites</u> sp. aff. <u>bosquensis</u> (Adkins) (UT, 10537)

<u>Submantelliceras</u> sp. (UT, 10800)

Gastropoda

several species of pyritic micromorphs (UT, 10537)

## Buda Limestone

The names "Shoal Creek limestone", "Burnt limestone", and "Vola limestone", were replaced when Vaughan (1900) used the name Buda in describing the type locality on Shoal Creek in Austin (Adkins, 1933, p. 396). The Buda limestone outcrops continuously across Brushy Creek Quadrangle, but it thins to the north and occurs intermittently in Berry Creek Quadrangle four miles north of Georgetown. The absence of Buda in four places was associated with a small post-Buda structural high by Arrington (1954). Farther northward in Bell County, thin Buda is alternately present then absent (Adkins and Arick, 1930; Adkins and Lozo, 1951). Rolled boulders of decomposed Buda mark the northern extremity near Moody in McLennan County (Adkins, 1933).

Rabbit Hill and the adjoining cuesta are held up by the Buda limestone in the northeastern corner of Brushy Creek Quadrangle. An equally steep, though slightly lower, cuesta in the southeastern corner is also supported by the Buda formation. The area of outcrop is very narrow and thickly sprinkled with large honeycombed boulders unless covered by an outwashed mantle of Woodbine and Eagle Ford shale. The residual soil is very thin or absent and the profusion of boulders prohibits cultivation.

Near the southern boundary (Locality 5) 27 feet of Buda was measured and neither bottom nor top was exposed (Measured section 5, Figure 13). Approximately one mile down Brushy Creek Tydlaska (1951) measured 35 feet of Buda. Near the northern boundary (Locality 4) a thickness of only 19.5 feet separates known Del Rio marl from the Pepper shale. Slump blocks cover the lower contact and the true thickness is probably slightly less. Walls (1949) reported a total thickness of 16 feet east of Georgetown on the San Gabriel River. Thus, along the outcrop, the Buda thins to the north at the approximate rate of 3.5 feet per mile; it thickens to the east in the subsurface.

The Buda consists of light brownish-orange to cream, very hard, indistinctly-bedded to massive, glauconitic, oolitic, fossiliferous, crystalline limestone. The lower eight feet exposed on Brushy Creek is thinner-bedded and more nodular than the massive upper beds. A fossil detrital limestone stratum occurs below the thin (0.2 foot) granular shale stringer that marks the division between the upper and lower Buda. Near the northern boundary only massive limestone lithically resembling the upper Buda occurs.

<u>Gryphaea graysonana</u> and <u>Pecten roemeri</u> shells are dispersed throughout the Buda formation, but the latter are more

numerous in the coralliferous upper part. One individual of *Budaiceras* sp. was found in the thinner, irregular-bedded lower Buda 3 feet below the massive beds on Brushy Creek.

Representatives of the Buda fauna collected by the writer are:

Mollusca

Pelecypoda

*Exogyra clarki* (Shattuck) (UT, 10533)

*Pecten roemeri* (Hill)

*Gryphaea graysonana* (Stanton)

*Trigonia clavigera* (Cragin)

Cephlapoda

*Budaiceras* sp. (UT, 10545) not

Echinoderma

*Enallaster* sp. (UT, 10534)

Coelenterata

*Hexacoralla* sp.

Woodbine Group

Pepper Shale

Adkins and Arick (1930) first described the Pepper shale on Pepper Creek between Belton and Temple, Bell County. Later, this location supplied the name and became the type section of the Pepper formation (Adkins, 1933). The exact correlation of the Pepper shale within the upper Woodbine group is unknown (Adkins and Lozo, 1951, p. 116), but it is thought to be a southern extension of some part of the Lewisville formation (op. cit. p. 113).

In Brushy Creek Quadrangle, the small area of outcrop of Pepper shale was covered by deep, black, clay-like residual soil, outwash from the steep slopes of the overlying Eagle Ford group, or terrace gravels. In the extreme northeastern and southeastern corners of this area the Pepper outcrops on the dip slope of high (100 feet) Buda cuestas. The only other outcrop is near the eastern boundary line on the downthrown side of Chandler fault.

That the lower contact is unconformable and regionally angular in Williamson County is substantiated by the northward thinning and absence of the Buda formation. A basal pebble conglomerate and reworked zone represents the unconformity at the type section in Bell County (Adkins and Arick, 1930). The upper contact has also been reported to be unconformable (Adkins and Lozo, 1951). Obvious changes in slope and topsoil mark the lower contact in Brushy Creek Quadrangle. Obscurity of higher contacts compelled this writer to combine the Woodbine group, represented by the Pepper shale, and the Eagle Ford group into one map unit.

The Pepper shale consists of dark gray to black, weathering to buff and gray, fissile, gypsiferous shale. The exact thickness was unobtainable in this area, but Arrington (1954) measured 19 feet and 15 feet north of Georgetown, and Tydlaska measured 13 feet 2 miles northeast of Round Rock. On Rabbit

Hill in the northeastern corner of Brushy Creek Quadrangle the writer estimates the thickness to slightly exceed 10 feet.

No fossils were found in the Pepper shale in this area.

Eagle Ford Group

First described by Roemer in 1852 and named by Hill in 1887 for the outcrop at Eagle Ford, Dallas County, this group was divided into three units by Moreman (1927). The Terrant, Britton, and Arcadia Park formations in ascending order were described at type localities in north Texas. Later, Adkins and Lozo (1951) divided the Eagle Ford group into two formations and described type sections near Waco in central Texas. The lower limestones and shales composed the Lake Waco formation, further subdivided into the Bluebonnet flags, Cloice shale, and Bouldin flags. The upper shale was named the South Bosque marl by Prather (1902). Both upper and lower contacts of the Eagle Ford group are reportedly unconformable in central Texas (Adkins and Lozo, 1951).

Limited outcrop areas of both formations occur in the northeast and southeast corners of Brushy Creek Quadrangle. The soil is light brown to black with scattered streaks of white. Cultivation of all but the steepest slopes yields a good harvest of cotton and corn. That part reserved for grazing supports a more profuse overgrowth of mesquite than the Del Rio formation.

Detailed descriptions of the Eagle Ford formations were not obtainable because of gravel, alluvium, or residual soil cover. The lack of fossils prohibited correlation with the established zones, but the "Bluebonnet" and Bouldin flags form slight ridges and are exposed in a road cut on the south side of Rabbit Hill in the northeast corner of the area. The intervening shales are obscured. The thickness of Eagle Ford sediments on Rabbit Hill is 41 feet (Measured section 6, Figure 14); approximately six miles northeast at Townes Mill the total thickness is 58 feet (Adkins and Lozo, 1951). Tydlaska (1951) described 45 feet in Palm Valley Quadrangle and did not report finding the "Bluebonnet flags".

The "Bluebonnet flag" member consists of 4.6 feet of brownish red to gray, hard, thin-bedded (0.1 to 0.5 foot), sandy limestone with stringers of bentonite and light brown to white, soft to fissile, laminated shale. Inoceramus and Ostrea sp. occur sparsely in this member. The Cloice member is a light greenish-gray to tan, soft to fissile, indistinctly bedded shale with bentonitic and sandstone stringers in the upper nine feet. The Bouldin flag member is light gray to tan, hard, thin-bedded (0.2 to 1.0 foot), very arenaceous limestone with stringers of tan to white, soft, bentonitic shales.

The South Bosque marl is covered in Brushy Creek Quadrangle but was described in Bell Gin Quadrangle as a yellow brown, soft, friable, laminated shale, containing many small shell fragments, rare Baculites gracilis (Shumard), Prionocyclus sp., scattered Inoceramus fragilis (Hall and Meek), and shark teeth (Walls, 1950).

## Austin Group

The Austin group was zoned using biostratigraphic criteria by Marks (1950) in Jonah Quadrangle. Young and Marks (1952) described five Austin Chalk zones and one Burditt marl zone in Williamson County. The Inoceramus subquadratus (Schlüter) zone disconformably overlies the Eagle Ford group; subsequent zones in ascending order are: Inoceramus undulatoplicatus (Roemer), Texanites "internodosus" (Renz), Gryphaea aucella (Roemer), Exogyra laeviuscula (Roemer), and Ostrea centerensis (Stephenson). The latter is a zone in the lower Burditt marl and in Travis County underlies the Ostrea travisana (Stephenson) zone described by Stephenson (1937).

The Inoceramus subquadratus zone was divided into subzones on a faunal basis by Arrington (1954). Only the lower I. subquadratus subzone below the Peroniceras sp. aff. westphalicum (Schlüter) subzone is present in Brushy Creek Quadrangle. A few cultivated acres in the northeastern corner constitute the Austin Chalk outcrop in this area. The topsoil is light to dark brown and white in some places due to thinness. The higher elevation accords a more erosive surface run-off, thus prohibiting the accumulation of a thick mantle of residual soil.

The part of the Austin Chalk exposed in Brushy Creek

Quadrangle consists of light gray to white, indurated, thin to medium-bedded, nodular, chalky limestone, alternating with light gray, laminated, calcareous shale. The thickness was calculated to be 25 feet, of which 22 feet are exposed at Locality 7 (Measured section 7, Figure 15). The diversity of the fauna is severely restricted in this subzone, but Inoceramus subquadratus occurs in abundance. A thin limestone, forming a slight ledge 18 feet above Eagle Ford shale at Locality 7, yielded several individuals of Scaphites sp. and one individual of Peroniceras sp. aff. westphalicum (Schlüter).

The following fossils were collected from Locality 7 by the writer:

Mollusca

Pelecypoda

Inoceramus subquadratus (Schlüter)

Cephalapoda

Scaphites sp. (UT, 10547)

Peroniceras sp. aff. westphalicum (Schlüter) (UT, 10548)

Ammonite fragments (UT, 10550)

## CENOZOIC SEDIMENTS

The Cenozoic deposits in Brushy Creek Quadrangle contain profuse pebbles and cobbles of Edwards chert. These deposits were divided into three lithic units by the writer (Plate 9). The oldest unit, herein referred to as the "Uvalde" gravel, occurs on topographic highs, and is underlain by the less resistant of the Cretaceous formations. The locations of the "Uvalde" gravel indicate no conformation to the present drainage pattern. Outcrops of the two younger lithologic units are restricted to the present stream valleys. The highest terrace occurring along the larger creeks and branches is built on consolidated gravel and was named "Brushy Creek" terrace by Tydlaska (1951). The lower terraces are alluvium and gravel, usually unconsolidated.

### "Uvalde" Gravel

The upland gravels, deposited as outwash around the Edwards Plateau, were named by Hill (1891). The gravels occur throughout central Texas, and are considered to be of Pliocene or early Pleistocene age (Plummer, F. B., 1933). The areal extent and present topographic position belie recent deposition, but the age has yet to be substantiated by fossil evidence.

Remnants of "Uvalde" terraces cap the topographic highs east of the Balcones faults in Brushy Creek Quadrangle. The highest outcrop occurs at the top of Rabbit Hill and overlies shale of the Eagle Ford group. A lower terrace caps the low hills parallel and east of Highway 81 (Plate 9). The thin veneer consists of light bluish-gray to brown and black, loose pebbles and cobbles of Edwards chert. Although superficially rocky, the soil is deep, black, and productive for cotton, corn, and row feeds.

### "Brushy Creek" Terrace and Associated Gravel

The highest terrace conforming to the present drainage pattern was named the "Brushy Creek" terrace by Tydlaska (1951). This terrace varies in width up to 0.1 mile and attains thicknesses up to 20 feet. It is present only along the larger creeks and branches and east of the Edwards outcrop. Typical exposures occur on Brushy Creek south of the dam at Round Rock, near Locality 14 on Onion Branch, and at the intersection of Chandler Branch and Chandler Fault. This terrace is composed of light brown, hard, non-bedded chert pebble conglomerate, with an argillaceous, calcareous matrix. The pebbles are noticeably smaller than the "Uvalde" chert pebbles. The soil is thin, light brown and rocky; it is seldom cultivated.

### Younger Stream Gravels and Alluvium

The rounded chert and limestone pebbles and cobbles that compose the stream gravels illustrate poor sorting. Thin (2 feet) deposits of more angular cobbles, cemented by a travertine matrix, occur west of the Balcones faults. East of the

Edwards outcrop the thickness of poorly sorted gravel and clay varies up to the 20 feet exposed in an under-cut bank near Locality 9. In Chandler Branch near Locality 10, many reworked Georgetown and Del Rio pelecypods are imbedded in a shaley matrix, but no Pleistocene fossils were found.

West of the Balcones faults only the small areas of alluvium deposited on slope banks are adaptable to cultivation. The soil is deep, black, and usually utilized for truck gardening. East of the Edwards outcrop alluvium deposits retain continuity along the streams. The rich bottom land is extensively cultivated and productive for cotton and corn.

## S T R U C T U R A L   G E O L O G Y

### REGIONAL

The Llano Uplift, Balcones Fault Zone, and Luling-Mexia Fault Zone are the dominant structural features of central Texas. Erosion of the thick blanket of Cretaceous cover has exposed the Llano Uplift in Llano and adjacent counties. East of the Llano Uplift a gentle homocline, cut by the Balcones Fault Zone, dips Gulfward across Williamson County. The trend of the Balcones Fault Zone across central Texas is paralleled to the east by the Luling-Mexia Fault Zone. The former is downthrown toward the east from southern Williamson County south; the latter includes faults downthrown toward the east and west. Minor faulting occurring between the Balcones and Luling-Mexia Fault Zones (Hartwig, 1952) indicates that the separation of these two zones may result because intervening argillaceous formations obscure faults on the outcrop (Young, personal communication).

### LOCAL

Paleozoic rocks have steep dips below the subsurface Wichita Paleoplain in Williamson County, but subsurface structural interpretations are at present conjectural due to lack of data.

The surface structure in Brushy Creek Quadrangle is a homocline gently dipping toward the Gulf of Mexico, and breached along the strike by the Balcones faults. Three major faults all downthrown on the southeast side extend into this area, and numerous minor faults occur proximal and strike slightly oblique to them (Figure 8). The joint systems and anomalies from the regional dip are also subjugated to the major faults.

### Attitude of Strata

West of the Balcones Fault Zone in Brushy Creek Quadrangle the Edwards limestone strikes N. 7° W., and dips at the rate of 51 feet per mile. These numbers are averages of data and were derived on a regional basis. Strike and dip measurements obtained proximal to and east of the fault zone in Brushy Creek Quadrangle did not contain the degree of consistency necessary for regional consideration. The structural contour map of this part of the area (Plate 8) shows the strata are slightly tilted down toward the northeast, due to faulting.

The presence of a structurally high area was first indicated by strike and dip data, and later substantiated by structural contours on the top of Georgetown Member C. The small structurally high area is isolated on the downthrown side of Three-Mile Fault, but because of insufficient control the exact extent of this feature is unknown.

### Major Faults

The names of the three major faults as encountered from east to west across Brushy Creek Quadrangle (Plate 10) are

Chandler, Three-Mile, and Onion. Chandler Fault (Tydlaska, 1950) enters the area from the south near Round Rock striking N. 40° E. Near Locality 11 Member A of the Georgetown formation is faulted against lower Del Rio clay and the minimum throw is estimated to be 75 feet. Just downstream (100 feet) from the Brushy Creek dam, the upper part of Member A is faulted against lower Buda and the minimum throw is 130 feet. Chandler Fault crosses the eastern boundary at Chandler Branch striking N. 30° E., and the estimated throw placing Georgetown Member B against lower Eagle Ford shale exceeds 125 feet.

The southern extremity of Three-Mile Fault (Plate 10) originates in the vicinity of the Leander-Cedar Park road fork near Brushy Creek two miles northwest of Round Rock. The fault strikes N. 30° E. to Chandler Branch. Where Highway 81 crosses this fault three miles north of Round Rock, the minimum throw is 50 feet. The name <u>Three-Mile Fault</u> was chosen by the writer because of the lithologic contrast of Edwards limestone faulted against shale of Georgetown Member B at this location. North of Chandler Branch the strike swings to N. 15° E.; at Locality 9 Georgetown Member C is faulted against upper Edwards limestone, and the minimum throw is 48 feet. This fault breaches the Buda scarp on Hawkins Farm near Localities 4 and 6 and the throw is decreased to 20 feet. Three-Mile Fault hinges out near the summit of Rabbit Hill in the northeastern corner of Brushy Creek Quadrangle.

The name Onion Fault was chosen because the southern extremity of this fault was first perceived in the small stream-beds at the headwaters of Onion Branch. The fault extends southward across Dry Brushy and Brushy Creeks, but the exact localities are covered by gravel. Northward to Chandler Branch the strike is N. 32° E. Edwards limestone is on both sides of the fault and the amount of throw is unknown. Near the Chandler Branch railroad bridge the strike swings to N. 15° E., and Georgetown Member A is downthrown against Edwards limestone. The entrance of Georgetown Member B into the fault 0.5 mile farther north indicates that the throw increases northward. Ward (1949) estimated the throw to be 214 feet at a point one mile north of the northern boundary. A detailed study of the Edwards formation must precede verification of the amount of throw along this fault.

## Minor Faults

The bedrock of Brushy Creek Quadrangle is broken by many minor faults. A minimum of 20 minor faults with displacements ranging from 6 inches to approximately 50 feet were seen by the writer (Figure 8). The minor faults were invariably found proximal to the major fault zones. An average angle of intersection between the strikes of major and minor faults approximates 30 degrees, but intersections varying from 5 degrees to 45 degrees occur. With rare exceptions in this area the acute angle points in the direction of increasing throw on the major fault.

Minor faults in the Comanche Peak formation cross Brushy Creek near the western boundary. The exact displacement here is unknown, but the strike of the faults is N. 10° W. to West. Two small, high-angle (57°, 65°), reverse faults intersect at this location striking N. 10° W. and West, and the latter is offset 2 feet. Several minor faults are exposed in Onion Branch 100 yards north and south of the Highway 79 bridge. Limited exposures of Georgetown Members A, B, C, and D occur at this location (Locality 17).

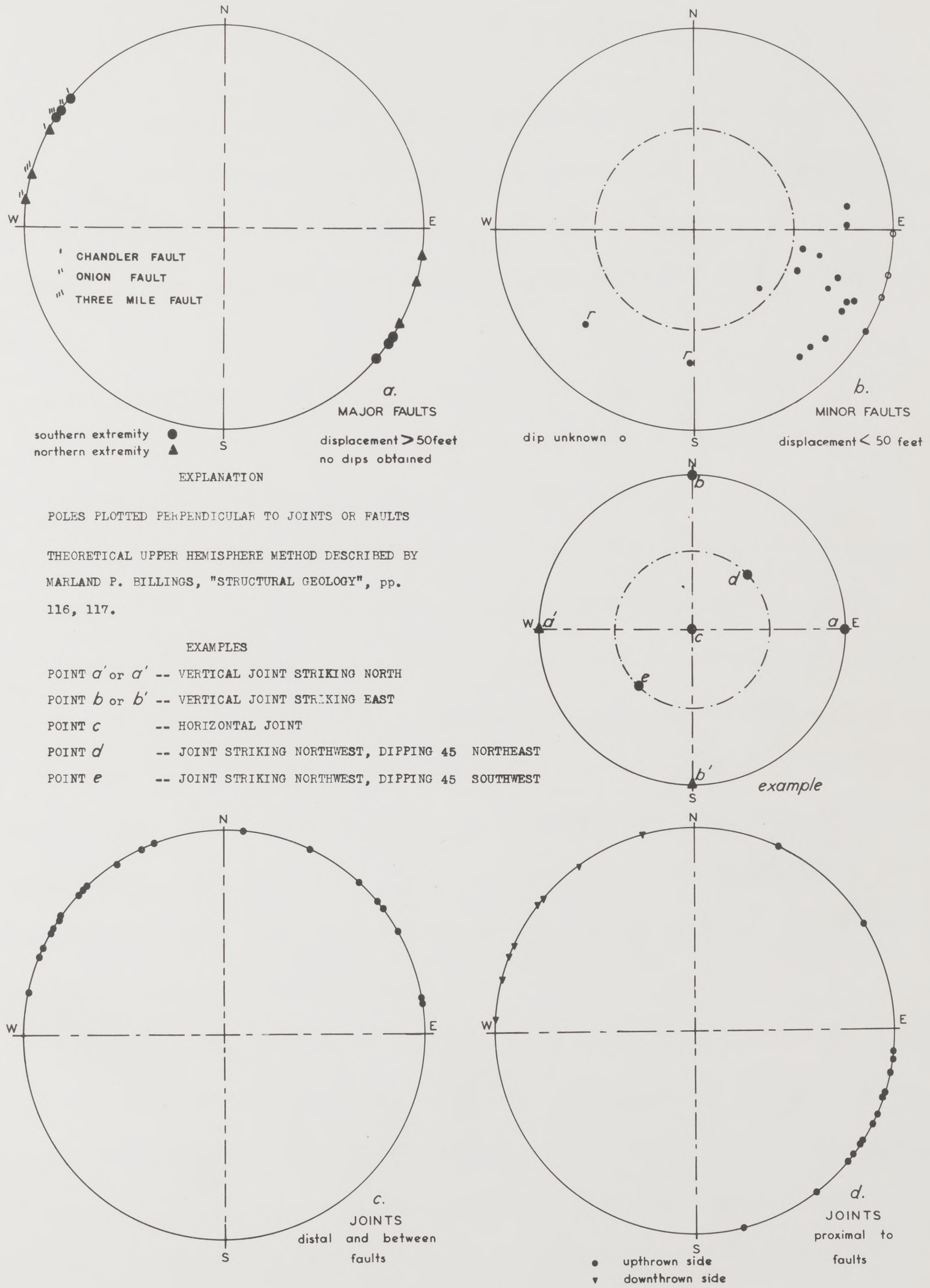
The east fork of Onion Fault is a minor fault with an estimated throw of 45 feet where it crosses Highway 81 near the northern boundary. The upper part of the Del Rio clay is downthrown on the east against Georgetown Member D at this location.

A lateral fault, connecting Three-Mile Fault and the east fork of Onion fault, is inferred in the northeast part of the area. The strike of this fault is estimated to approximate N. 40° W., but the exact nature of this lateral fault is unknown. That the fault exists and has a minimum throw of 20 feet is proven by the topographic relationship of outcrops of Del Rio clay and limestone of Georgetown Member E. An outcrop of lower Del Rio clay is topographically lower than an adjacent outcrop of the underlying Georgetown Member E.

## Joints

The joint system in Brushy Creek Quadrangle is composed of two indistinct sets of tension joints (Figure 8). The genetic classification, tension, is substantiated by the relationship between the joint and fault planes. The most obvious set, herein referred to as the primary joint set, approximately parallels the strike, N. 30° E., of the major faults. Less obvious, geometrically classified, oblique joints constitute the secondary joint set and strike N. 15° W. to N. 60° W. The joints of both sets are vertical.

The age relationship between the joint sets was indeterminable, but no essential age difference was apparent. The joints are usually filled with soil, and no prevalent abutting was noticed by the writer.




EACH POINT REPRESENTS ONE JOINT SET IN ONE LOCALITY

Figure 8.

# E C O N O M I C   G E O L O G Y

The economy of Brushy Creek Quadrangle depends solely upon soil and water. Other natural resources are limestone and road material. The area has no oil or gas production, although a few shallow wells have been drilled with rumored shows of oil.

Agriculture.-- The soil map of Williamson County published by the U. S. Soil Conservation Service (1927) shows a striking degree of parallelism to the bedrock. For this reason the physical characteristics of the soils are herein included with the parent rock unit. The thin rocky soils of the Edwards formation and Member A of the Georgetown formation are used for grazing. Cattle, sheep, and goat ranching is the chief industry in the western part of Brushy Creek Quadrangle. The major source of revenue is the sale of livestock, wool, and mohair. The eastern part of this area is cultivated land, and depends upon the exportation of cotton, corn, and grain for revenue.

Water.-- The average annual rainfall in Williamson County slightly exceeds 30 inches, and the prosperity of this area is largely dependent upon when and how the precipitation occurs. Unfortunately, a large percentage of the spring and fall moisture is lost to rapid surface run-off, and a drought occurs in the late spring and summer growing season. The innovation of terrace and pond construction, and contour plowing partially controls land deterioration and increases the yield per acre.

Numerous seeps and springs issue from porous strata in the Edwards formation in the western part of the area, and sands of the Travis Peak formation are good subsurface artesian aquifers. Three separate artesian water horizons in the Travis Peak formation are reportedly encountered at depths from 1200 to 1400 feet in the eastern part of the area, and potable water is obtained from the Edwards limestone at depths ranging up to 300 feet. The hydrostatic head raises Edwards water to approximately 175 feet below the Buda at Hawkins Farm (Locality 4). Shallow wells depending on vadose and phreatic water are unreliable in the dry summer months unless they extend down into thick stream gravel.

Limestone.-- Three quarries are in operation in the vicinity of Round Rock at the time of this writing. Relatively pure calcium carbonate is quarried from the lower part of the upper belt of the Edwards limestone on Lake Creek, approximately one mile southwest of Round Rock, and one mile west of Round Rock on Brushy Creek. Limestone and dolomite are quarried from the lower belt of the Edwards limestone, four miles west of Round Rock on Brushy Creek. Superior Stone Products, Inc., operates the quarries on Brushy Creek. At present, crushed limestone is exported for use in smelting tin, and pulverized limestone and dolomite are marketed as ingredients for livestock feed and fertilizers. The quarry on Lake Creek is operated by Round Rock White Lime Company. The major product of their kiln is quicklime. Edwards limestone is used locally as building stone.

Road Material.-- Two physical properties are necessary for good road material, a resistant body and a binding or consolidating component. Three suitable types of road material are available in Brushy Creek Quadrangle in commercial quantities. Stream gravel containing a binding calcareous clay content is available on Brushy Creek at Round Rock, and on Chandler Branch near Localities 9 and 10. Gryphaea shells in a calcareous clay are also available at Locality 9, and along Highway 81, 0.3 mile south and 1.2 miles north of Three Mile Fault. Crushed limestone, too small for the Round Rock White Lime Company kilns, is currently being used as road ballast between Taylor and Coupland in Williamson County.

# C O N C L U S I O N S

Prior to the completion of the research, numerous interpretations pertaining to the stratigraphy and structure in Brushy Creek Quadrangle were indicated by the accumulating data. The interpretations, reaffirmed by additional investigation, enabled the writer to derive certain conclusions concerning this area. The data herein submitted substantiates the conclusions enumerated below:

Stratigraphic

a. The Edwards limestone contains at least three distinctly different lithologic units in this area.

b. The Edwards limestone directly and unconformably underlies strata of the "Kiamichi" and Georgetown formations. The local discordance is very small, and the upper Edwards beds are locally truncated at a low angle as the result of pre-"Kiamichi" and pre-Georgetown erosion.

c. The isolated "Kiamichi" exposures in Brushy and Lake Creeks at Round Rock are remnants preserved in pre-Georgetown topographic lows. The lithology of the "Kiamichi" does not indicate that the absence of this formation in nearby exposures is due to lack of deposition, but the result of pre-Georgetown erosion.

d. Referent to the members of the Georgetown formation, the previous use of guide fossils is reaffirmed.

e. Georgetown Member A thins slightly toward the south, and the limestone content of Member B increases northward in Williamson County.

f. An epibole of Hemiaster (Macraster) elegans (Shumard) persists in the upper five feet of Georgetown Member B, and Leonites n. sp. 2 and L. n. sp. 3 are additional guide fossils for this unit.

g. The uppermost five feet of Georgetown Member E is a zone of interfingering transition into the Del Rio clay.

h. The thick section of clay underlying the Buda limestone in central Texas is more appropriately labeled Del Rio than "Grayson".

i. The Buda limestone thins toward the north. The massive upper Buda limestone beds thin at a less marked rate than the lower Buda nodular limestone beds which are absent in the northern part of Brushy Creek Quadrangle. Either an intraformational unconformity occurs within the Buda limestone or the upper part of the Del Rio clay is laterally equivalent to the missing beds of lower Buda limestone.

Structural

a. The Balcones Fault Zone trends N. 30° E. across Brushy Creek Quadrangle, and the faults strike parallel to the zone. This is not true in Berry Creek Quadrangle to the north (Arrington, 1954). South of Austin the major faults strike about 30° east of the trend of the zone. The parallelism of fault strike and fault zone trend in Brushy Creek Quadrangle apparently results from a swing in the trend of the fault zone to the west toward Austin and from a convergence of the major faults toward Austin (Young, personal communication). The faulting resulted from a southeast-northwest tensional force.

b. The joint system is also the result of a southeast-northwest tensional force, thus the jointing occurred simultaneously with the faulting. That the trends of the individual faults, the fault zone, and the primary joint set are the same, N. 30° E., support this age relationship.

c. The highest stratigraphic unit breached by Balcones faults in this area is the lower Inoceramus subquadratus (Schlüter) subzone of the Austin chalk. The age of the faulting is therefore post-Coniacian and pre-Pleistocene. The abrupt influx of reworked Cretaceous fossils in the Moulton sandstone indicates that the major part of the Balcones faulting began in the Miocene Epoch.

d. A small structural high occurs in the east central part of Brushy Creek Quadrangle. This small structural feature was isolated against the upthrown side of Three-Mile Fault by fault drag. The small inconsistencies of strike and dip are the result of adjustment of the strata during faulting.

# A P P E N D I X   I

## LOCALITIES

## LOCALITIES

Specific localities, referred to herein by number, were used to facilitate areal orientation. The localities are plotted on Plate 10 and listed below:

| Number | Location |
|---|---|
| 1 | Locality 1 is in the bed of Brushy Creek, near the southwestern corner of the area, 0.7 mile east of the stream fork. Comanche Peak fossils, minor faulting, and the Comanche Peak-Edwards contact occur at this locality. Section 1A was measured on the south bank of Brushy Creek. |
| 2 | Upper Edwards, "Kiamichi", Member A and lower Member B of the Georgetown formation outcrop on the south bank of Brushy Creek 100 yards upstream from the Highway 81 bridge at Round Rock. Section 2 was measured here. |
| 3 | Almost a complete section of the Georgetown formation is exposed east of Highway 81 (0.6 mile), north of Brushy Creek Bridge at Round Rock (2.4 miles), and northeast of Chandler Branch (0.1 mile). Members B, C, D, and E of the Georgetown are exposed in a narrow ditch on E. T. Flewellen Farm. Section 3 was measured here. |
| 4 | Abundant fossils were collected from the Del Rio clay east of Highway 81 (0.9 mile), near the northeastern corner of Brushy Creek Quadrangle, on Hawkins Farm. Pyritic micromorphs occur here. Section 4 was measured here and section 5B was measured nearby on the Buda scarp. |
| 5 | Locality 5 is along the eastern boundary of the area between Highway 79 and Brushy Creek. The upper part of the Buda is exposed along a ditch on Stark Farm. Section 5A was measured here. A better but less accessible outcrop of Buda occurs on Brushy Creek 0.2 mile upstream from this locality. |

| Number | Location |
|---|---|
| 6 | Near the northeastern corner, along the gravel road bearing north across Rabbit Hill, upper Buda, Pepper soil, Bluebonnet flags, and limited Eagle Ford shales are exposed in the road ditch. Section 6 was measured here. |
| 7 | A good fossil collecting locality in the lower part of the Austin chalk occurs in the extreme northeastern corner of this area on Lawson Farm. The sloping hillside on the west of a small draw north of the highest tank exposes lower Austin Chalk. Upper Eagle Ford shale is exposed in the lower tank, but the contact is obscured by residual soil. Section 7 was measured here and numerous *Scaphites* were collected. |
| 8 | Locality 8 is in a small branch 0.8 mile east of Highway 81. The branch roughly parallels Three-Mile Fault and is an eastern fork of Chandler Branch. The upper part of Member E contains shale beds, *Exogyra arietina*, and contacts the Del Rio formation at this location. |
| 9 | An abandoned road material pit on Dedear Ranch 0.3 mile east of Highway 81, on the same branch as locality 8 but 0.7 mile downstream, offers excellent fossil collecting from Members B, C, and D of the Georgetown formation. A minor fault crosses the branch here, and 0.3 mile downstream thick recent gravel is exposed in an undercut streambank. |
| 10 | A tank at McAdams Farm, on the south bank of Chandler Branch, near the eastern boundary yielded several ammonites. Freshly exposed rocks of Members B and C of the Georgetown formation occur in the tank. Member E outcrops on the low hill to the southwest, and along the east-west road consolidated "Brushy Creek" terrace is exposed. |
| 11 | Locality 11 is along Lake Creek in southern Round Rock. The stream bed under the railroad bridge is Edwards limestone, the north bank is "Kiamichi" and Member E of the Georgetown formation. A minor fault occurs in the latter in a small branch feeding into Lake Creek from the south. |
| 12 | Quigley quarry is between Leander road and Brushy Creek 3.5 miles west of Round Rock. The dolomite quarried from this locality occurs in the upper |

| Number | Location |
|---|---|
| | part of the lower belt of the Edwards formation. The dip of the strata in this locality indicates proximal faults. |
| 13 | A quarry is located across Leander road from Superior Stone Products, Inc., and 1.5 miles up Brushy Creek from Round Rock. The limestone quarried here contains several bands of nodular black chert, and is in the middle and upper belts of Edwards limestone. |
| 14 | The "Kiamichi" formation outcrops on the north bank of Onion Creek 0.1 mile downstream from the railroad bridge and 0.6 mile west of Highway 81. Numerous specimens of _Oxytropidoceras_ were found along Onion Creek at this locality. |
| 15 | Locality 15 is 0.5 mile west of Round Rock between the south bank of Brushy Creek and Farm Road 620. _Holectypus planatus_ was found in abundance on the floor of the old quarry at this locality. |
| 16 | Locality 16 is 1.0 mile west of Round Rock between Farm Road 620 and Brushy Creek. The top of the hill is an outlier of Georgetown limestone; the steep-sided creek bank is the upper belt of the Edwards limestone. Section 1C was measured here. |
| 17 | Numerous minor faults and parts of Georgetown Members A, B, C, and D are exposed in Onion Branch, 0.6 mile east of the Highway 79 and Highway 81 intersection north of Round Rock. Good exposures occur within 100 yards north and south of the Highway 79 bridge. |

# A P P E N D I X   II

## MEASURED SECTIONS

MEASURED SECTIONS IA, IB, AND IC

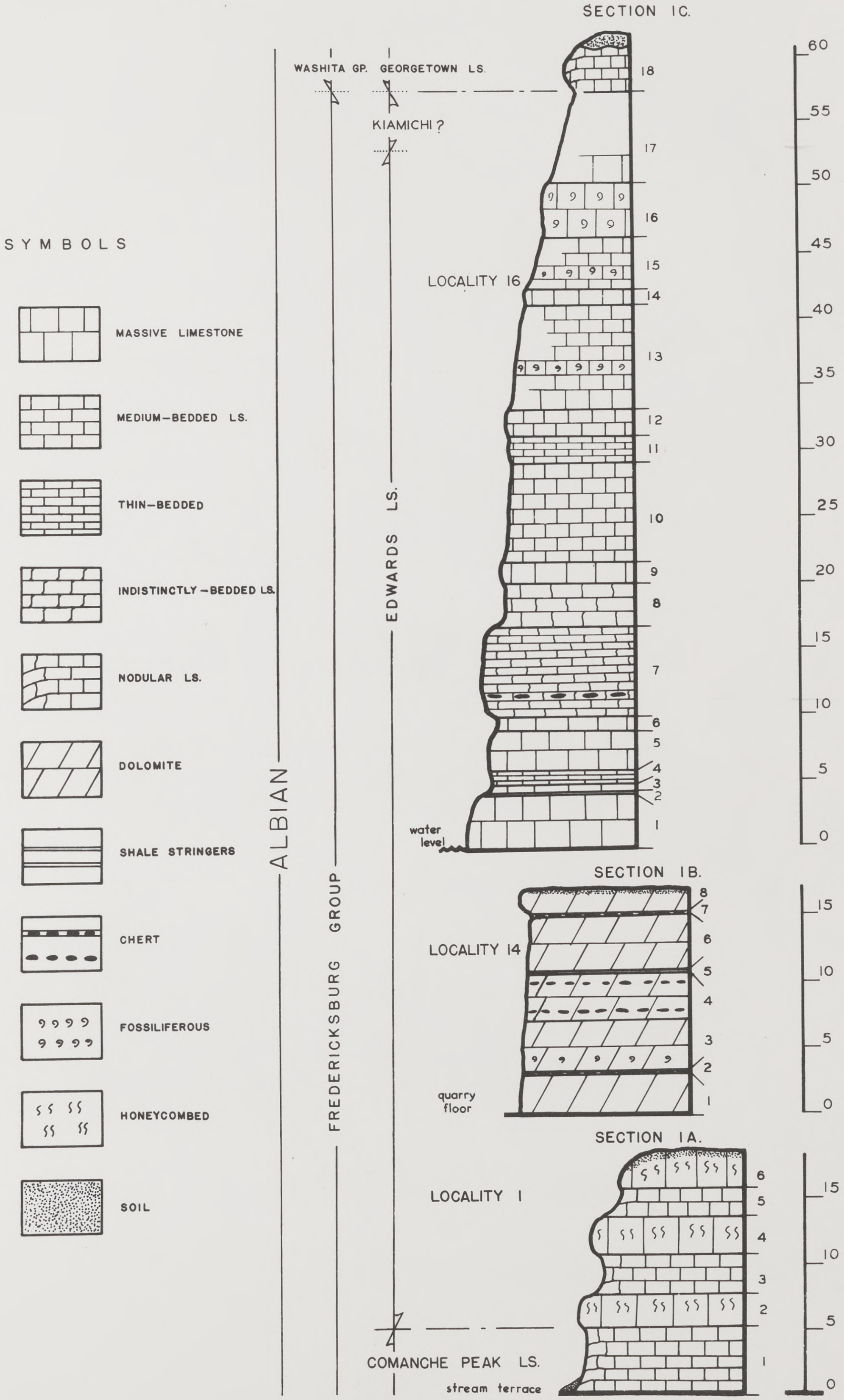



Figure 9.

## MEASURED SECTION 1A

Location: Section 1A was measured on the south bank of Brushy Creek 0.7 mile east of the stream fork near the southwest corner of Brushy Creek Quadrangle (Locality 1, Plate 10).

Edwards limestone

| Bed | Description | Thickness (feet) |
|---|---|---|
| 6 | Same as bed 4. | 2.8 |
| 5 | Same as bed 3. | 2.1 |
| 4 | Limestone, white to light brownish-gray, weathers dark gray, hard, massive, microcrystalline, pyritic, honeycombed, contains pyritic gastropods. | 2.7 |
| 3 | Limestone, white to light gray, hard, medium-bedded, nodular, microcrystalline. | 2.9 |
| 2 | Limestone, light brownish-gray, hard, dense, massive, macrocrystalline, honeycombed when exposed on surface. | 2.5 |
| | Total Edwards measured | 13.0 |

Comanche Peak limestone

| Bed | Description | Thickness (feet) |
|---|---|---|
| 1 | Limestone, white to light tan and gray, weathers dark gray, hard, medium-bedded, nodular, conchoidal fracture, contains large gastropods and <u>Protocardia texana</u>. | 5.0 |
| | Total Comanche Peak measured | 5.0 |
| | Total section measured | 18.0 |

## MEASURED SECTION 1B

Location: This section was measured at the Superior Stone Products, Inc. quarry, 3.5 miles west of Round Rock between Leander Road and Dry Brushy Creek (locality 12, Plate 10).

Edwards limestone

| Bed | Description | Thickness (feet) |
|---|---|---|
| 8 | Dolomite, light gray, medium hard, massive, porous, contains leached <u>Toucasia</u>. | 1.7 |
| 7 | Chert, light brown with gray and white bands, almost a continuous bed between bedding planes of the dolomite. | 0.1 |
| 6 | Dolomite, light gray, medium hard, friable, massive, porous, contains leached <u>Toucasia</u>. | 4.1 |
| 5 | Marl, yellow brown, soft, indistinctively-bedded. | 0.3 |
| 4 | Dolomite, light gray to light brown, medium hard, massive, argillaceous, thin layers of dark gray banded chert nodules occur 0.6 foot from the top and 0.5 foot from the base of this bed. | 3.6 |
| 3 | Dolomite, light gray, indurated, friable, massive, argillaceous, very porous, contains abundant <u>Toucasia</u>. | 4.0 |
| 2 | Chert, dark gray and white mottled chert nodules. | 0.1 |
| 1 | Dolomite, light gray, indurated, friable, massive, porous. | 3.0 |
| | Total Edwards measured | 16.9 |
| | Total section measured | 16.9 |

## MEASURED SECTION 10

Location: This section was measured between Brushy Creek and Farm Road 620 one mile west of Round Rock (locality 16, Plate 10).

Georgetown limestone

| Bed | Description | Thickness (feet) |
|---|---|---|
| 18 | Limestone, light gray to white, hard, medium-bedded, nodular, contains Gryphaea sp. The overlying float contains scarce fragments of Oxytropidoceras and numerous Mortoniceras. | 3.0 |
| | Total Georgetown measured | 3.0 |

Edwards limestone

| Bed | Description | Thickness (feet) |
|---|---|---|
| 17 | Covered, lower part probably same as 16. | 6.8 |
| 16 | Limestone, white to light gray, hard, massive, Toucasia biostromes. | 4.0 |
| 15 | Covered, some of the Toucasia biostromal detrital may not be float from 16. | 3.8 |
| 14 | Limestone, white to light gray, hard, massive, contains Toucasia sp. | 1.2 |
| 13 | Covered. | 7.8 |
| 12 | Limestone, light greenish white, hard, medium-bedded. | 2.0 |
| 11 | Limestone, light greenish white, hard, thin-bedded. | 2.0 |
| 10 | Limestone, light gray to white, hard, massive. | 7.6 |
| 9 | Limestone, light greenish white, medium hard, massive, contains miliolids. | 1.7 |

| Bed | Description | Thickness (feet) |
|---|---|---|
| 8 | Limestone, white, weathers dark gray, hard, irregularly-bedded, contains miliolids. | 3.4 |
| 7 | Limestone, light cream to white, weathers dark gray, hard, thin irregularly-bedded, a horizon of black chert nodules 0.2 foot thick occurs 1.0 foot from the base. | 6.8 |
| 6 | Limestone, light brown, medium hard, massive, argillaceous. | 1.1 |
| 5 | Limestone, light brown, medium hard, massive, contains small crystals of calcite. | 3.0 |
| 4 | Limestone, white, weathers to dark gray, hard, thin irregularly-bedded. | 1.0 |
| 3 | Limestone, white with greenish streaks, medium hard, medium-bedded, granular calcite. | 0.6 |
| 2 | Shale, light gray, slightly indurated, fissile, friable, laminated. | 0.2 |
| 1 | Limestone, light greenish gray, hard, massive, contains abundance of microfossils. | 4.0 |
| | Total Edwards measured | 57.0 |
| | Total section measured | 60.0 |

# MEASURED SECTION 2

LOCALITY 2

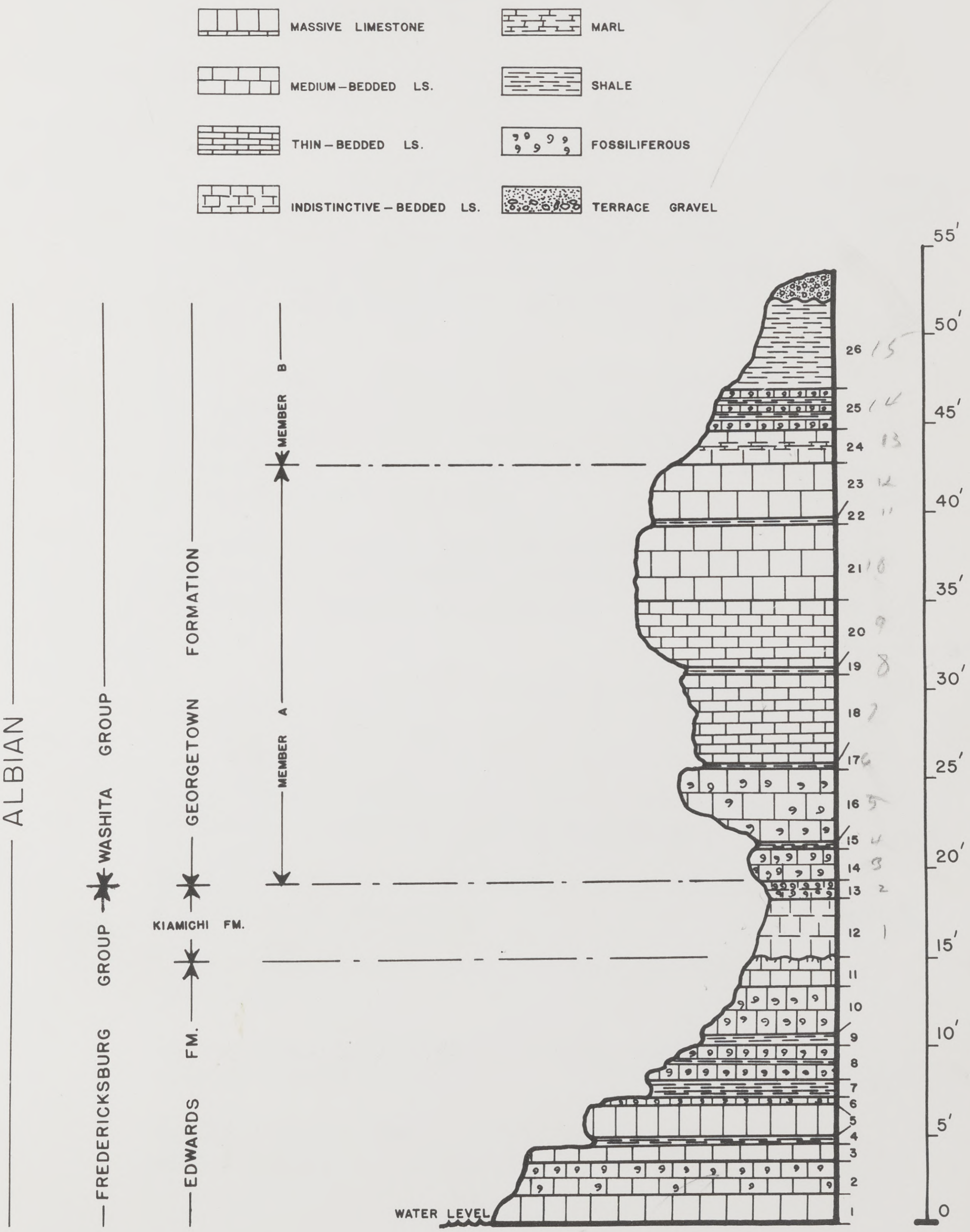



Figure 10.

## MEASURED SECTION 2

Location: Section 2 is exposed on Brushy Creek at Round Rock, 100 yards upstream from the Highway 81 bridge (Locality 2, Plate 10).

Georgetown limestone

Member B

| Bed | Description | Thickness (feet) |
|---|---|---|
| 26 | Shale, light gray weathering to tan, soft, laminated, calcareous, contains Pecten, Trigonia, and Kingena wacoensis. | 4.9 |
| 25 | Limestone, light tan to white, slightly indurated, thin-bedded, nodular, inter-bedded with shale, light gray to tan, soft, laminated, calcareous, contains Exogyra walkeri. | 2.4 |
| 24 | Limestone, light tan to white, indurated, medium-bedded, nodular, marly, contains Kingena wacoensis. | 1.8 |
| | Total Member B measured | 9.1 |

Member A

| Bed | Description | Thickness (feet) |
|---|---|---|
| 23 | Limestone, light gray, hard, massive, nodular, contains Mortoniceras sp. | 3.0 |
| 22 | Marl, light gray to tan, soft, fissile, slightly arenaceous. | 0.5 |
| 21 | Limestone, light gray, hard, massive, nodular. | 4.2 |
| 20 | Limestone, light gray, hard, medium-bedded, nodular. | 3.7 |
| 19 | Shale, light gray, fissile, friable, arenaceous, calcareous. | 0.5 |

| Bed | Description | Thickness (feet) |
|---|---|---|
| 18 | Limestone, light gray, hard, medium-bedded, nodular, contains Gryphaea washitaensis. | 5.1 |
| 17 | Shale, light gray to tan, fissile, friable, slightly arenaceous, calcareous. | 0.4 |
| 16 | Limestone, light gray, hard, massive, contains Idiohamites fremonti and abundant Gryphaea washitaensis. | 3.9 |
| 15 | Marl, light gray to tan, fissile, friable, slightly arenaceous. | 0.3 |
| 14 | Limestone, light gray, hard, massive, contains abundant Gryphaea washitaensis. | 1.7 |
| | Total Member A measured | 23.3 |
| | Total Georgetown measured | 32.4 |
| "Kiamichi" limestone | | |
| 13 | Limestone, light gray, hard, massive, marly, nodular, contains Gryphaea sp., Exogyra sp., and Oxytropidoceras belknapi. | 1.2 |
| 12 | Limestone, light brown to gray, hard, indistinctively-bedded, marly, contains Oxytropidoceras belknapi, O. cf. supani, and small inclusions of bed 11 near base. | 3.1 |
| | Total "Kiamichi" measured | 4.3 |
| Edwards limestone | | |
| 11 | Limestone, white, hard, massive, sublithographic, few Toucasias near upper contact, bore holes filled with bed 12. | 1.4 |

| Bed | Description | Thickness (feet) |
|---|---|---|
| 10 | Limestone, white, hard, indistinctively-bedded, caprinid and rudistid biostrome. | 2.8 |
| 9 | Shale, light gray, soft, friable, very thin-bedded, arenaceous, calcareous. | 0.8 |
| 8 | Limestone, light gray to white, hard, medium-bedded, contains *Toucasia* and stringers of calcareous shale. | 1.9 |
| 7 | Shale, light gray, soft, friable, very thin-bedded, slightly arenaceous, calcareous. | 0.9 |
| 6 | Limestone, light gray to white, medium hard, thin-bedded, contains miliolids. | 0.4 |
| 5 | Limestone, light greenish gray, hard, massive, sublithographic. | 1.7 |
| 4 | Shale, light gray, soft, friable, laminated, calcareous. | 0.5 |
| 3 | Limestone, light gray, hard, massive, sublithographic. | 0.9 |
| 2 | Limestone, light gray to white, hard, medium-bedded, contains fossil detrital. | 1.8 |
| 1 | Limestone, light gray to white, hard, massive. | 1.7 |
| | Total Edwards measured | 14.8 |
| | Total section measured | 51.5 |

# MEASURED SECTION 3

LOCALITY 3

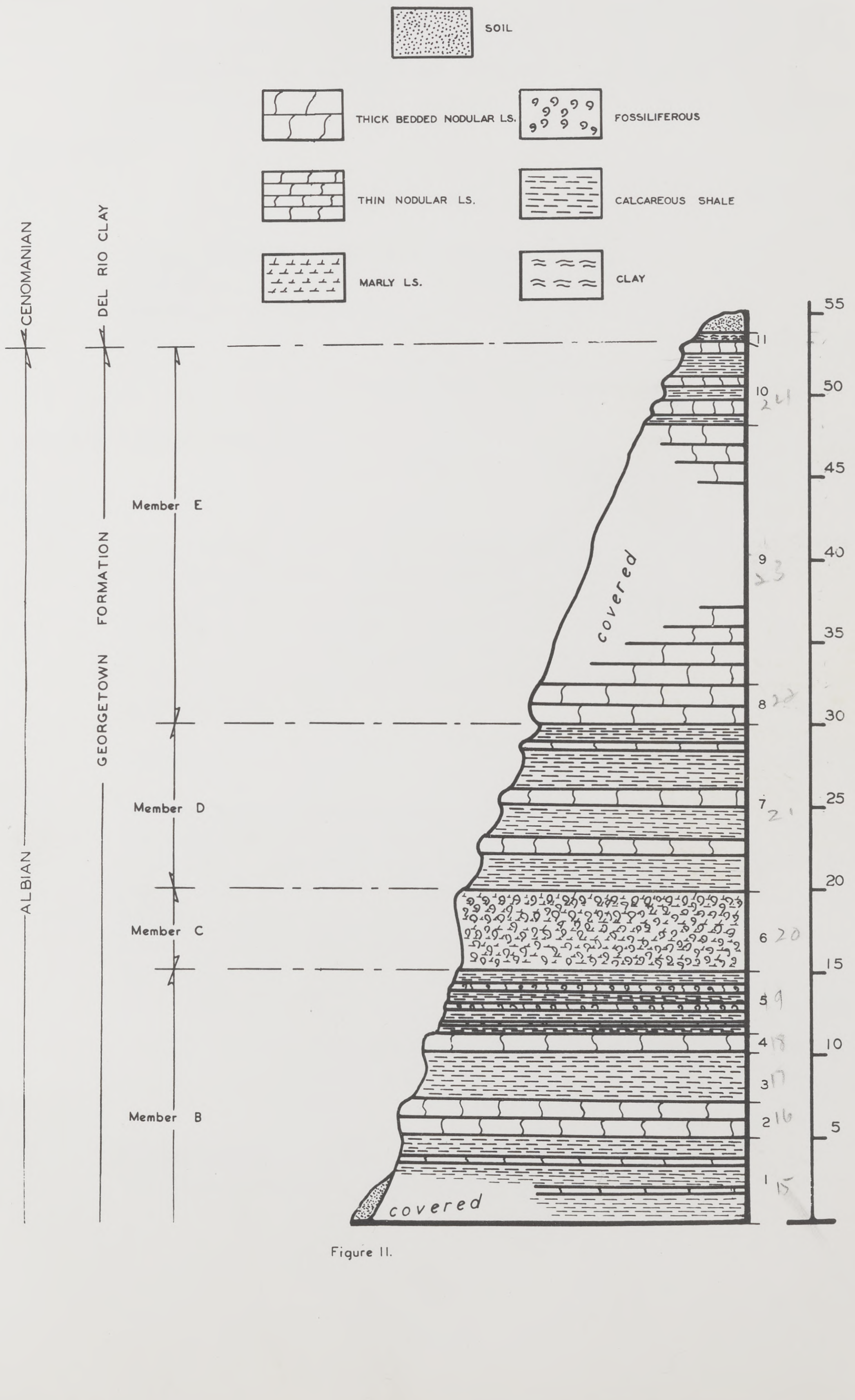



Figure 11.

MEASURED SECTION 3

Location: Section 3 was measured along a narrow ditch on E. T. Flewellen Farm 2.4 miles north of Round Rock, 0.6 mile east of Highway 81, and 0.1 mile northeast of Chandler Branch (Locality 3, Plate 10).

Del Rio clay

| Bed | Description | Thickness (feet) |
|---|---|---|
| 11 | Clay, light greenish-gray, soft, plastic, laminated, contains <u>Exogyra arietina</u>. | 1.1 |
| | Total Del Rio measured | 1.1 |

Georgetown limestone

Member E

| Bed | Description | Thickness (feet) |
|---|---|---|
| 10 | Limestone, white to light gray, weathers white and angular, hard, conchoidal fracture, nodular, interbedded with shale, light tan to white, laminated, calcareous, contains <u>Exogyra arietina</u> and <u>Kingena wacoensis</u>. | 4.8 |
| 9 | Covered. | 14.0 |
| 8 | Limestone, light gray, weathers tan to orange-brown, hard, thick-bedded, nodular, pyritic in lower part, upper part covered, contains abundant <u>Kingena wacoensis</u>. <u>Mortoniceras</u> n. sp. 4 found in lower 6 feet at nearby Locality 10. | 2.1 |
| | Total Member E measured | 20.9 |

Member D

| Bed | Description | Thickness (feet) |
|---|---|---|
| 7 | Limestone, white to light gray, thick to thin-bedded, nodular, indurated, | |

| Bed | Description | Thickness (feet) |
|---|---|---|
| | interbedded with shale, light gray to tan and white, soft, laminated, calcareous, contains Gryphaea washitaensis, Kingena wacoensis, and one Mortoniceras n. sp. 3 in shale 4 feet above base. | 10.1 |
| | Total Member D measured | 10.1 |
| Member C | | |
| 6 | Calcirudite, light gray to white, hard to crumbly, indistinctly-bedded, marly, profuse Gryphaea washitaensis. | 4.9 |
| | Total Member C measured | 4.9 |
| Member B | | |
| 5 | Limestone, white to light gray, indurated, medium to thin-bedded, nodular, contains profuse Kingena wacoensis, interbedded with shale, light gray to tan, soft, laminated, calcareous. | 3.8 |
| 4 | Same as bed 2. | 1.1 |
| 3 | Shale, light gray to tan, soft, laminated, fossiliferous, calcareous, contains Exogyra walkeri. | 2.9 |
| 2 | Limestone, light gray to white, indurated, medium-bedded, nodular, contains Kingena wacoensis and Exogyra walkeri. | 2.2 |
| 1 | Shale, light gray to white and tan, soft, laminated, calcareous, interbedded with limestone, white to tan, | |

| Bed | Description | Thickness (feet) |
|---|---|---|
| | indurated, thin-bedded, nodular, fossiliferous. | 2.3 |
| | Total Member B measured | 12.3 |
| | Total Georgetown measured | 48.2 |
| | Total section measured | 49.3 |

# MEASURED SECTION 4

LOCALITY 4

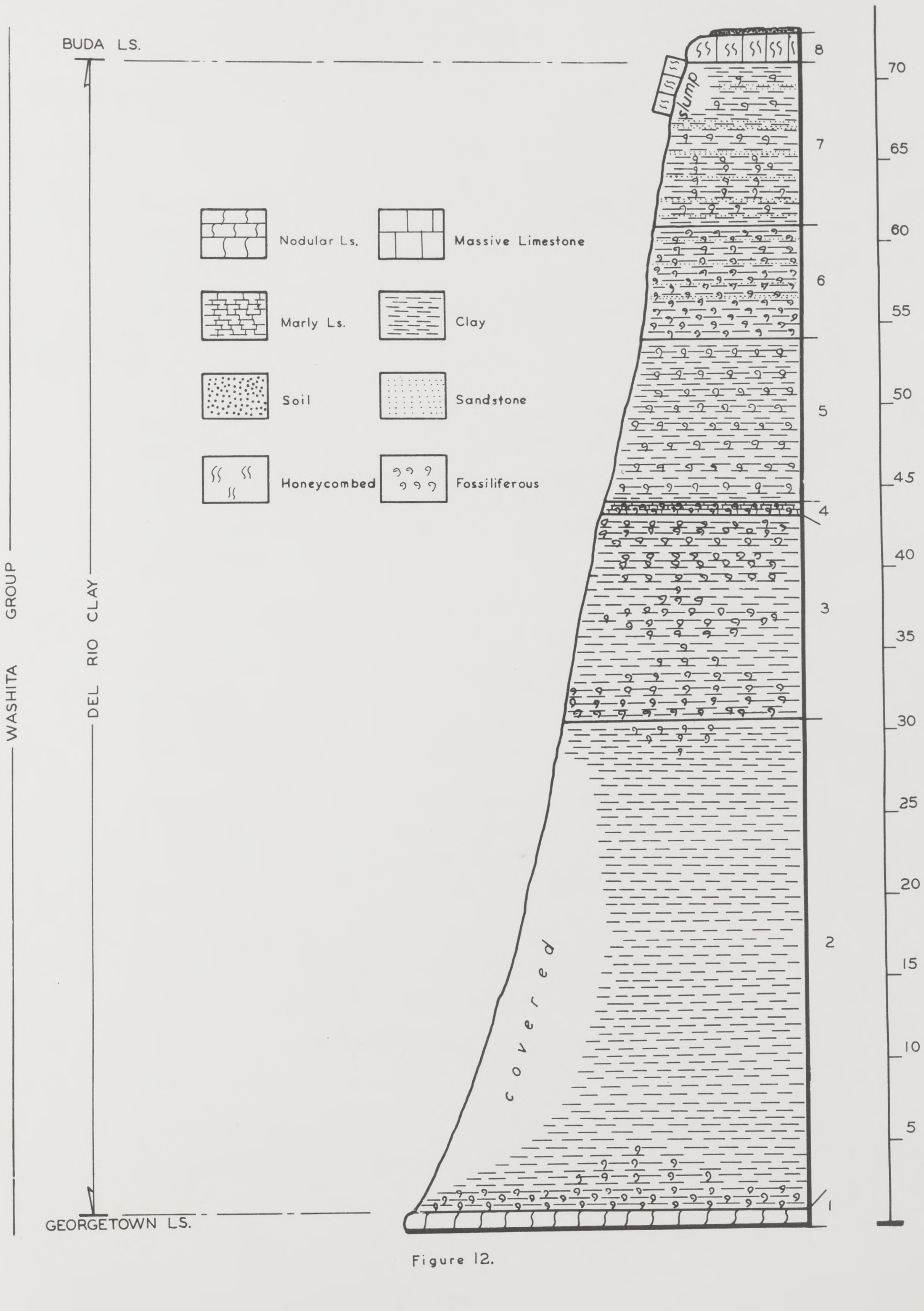



Figure 12.

## MEASURED SECTION 4

Location: Section 4 was measured on Hawkins Farm 0.9 mile east of Highway 81 near the northeastern corner of Brushy Creek Quadrangle (Locality 4, Plate 10).

Buda limestone

| Bed | Description | Thickness (feet) |
|---|---|---|
| 8 | Limestone, light yellow brown, hard, massive, honeycombed, fossiliferous. | 1.7 |
| | Total Buda measured | 1.7 |

Del Rio clay

| Bed | Description | Thickness (feet) |
|---|---|---|
| 7 | Clay, light greenish-gray to tan, soft, plastic, laminated, pyritic, contains *Gryphaea graysonana* and *Exogyra arietina*, interbedded with stringers of sandstone, light brown, indurated, thin-bedded, pyritic. | 10.0 |
| 6 | Clay, light greenish-gray, soft, plastic, laminated, pyritic, gypsiferous, contains *Gryphaea graysonana*, profuse *Exogyra arietina*, pyritic micromorphs of *Turrilites bosquensis*, gastropods, and *Submantelliceras* sp. | 7.0 |
| 5 | Clay, light greenish-gray, soft, plastic, laminated, gypsiferous, contains abundant *Exogyra arietina*, *Gryphaea graysonana*, and selenite crystals. | 10.0 |
| 4 | Calcirudite, light gray to white, indurated, indistinctly-bedded, contains profuse *Exogyra arietina*. | 0.9 |
| 3 | Clay, light greenish-gray, soft, plastic, laminated, gypsiferous, contains profuse *Exogyra arietina* and scattered pyritic micromorphs of *Turrilites bosquensis* in the upper part. | 12.5 |

| Bed | Description | Thickness (feet) |
|---|---|---|
| 2 | Covered, black to dark greenish-gray plastic soil. | 30.0 |
| | Total Del Rio measured | 70.4 |
| Georgetown limestone | | |
| Member E | | |
| 1 | Limestone, light gray to white, hard, medium-bedded, nodular, contains _Kingena wacoensis_ and _Exogyra arietina_. | 0.9 |
| | Total Member E measured | 0.9 |
| | Total section measured | 73.0 |

# MEASURED SECTIONS 5A & 5B

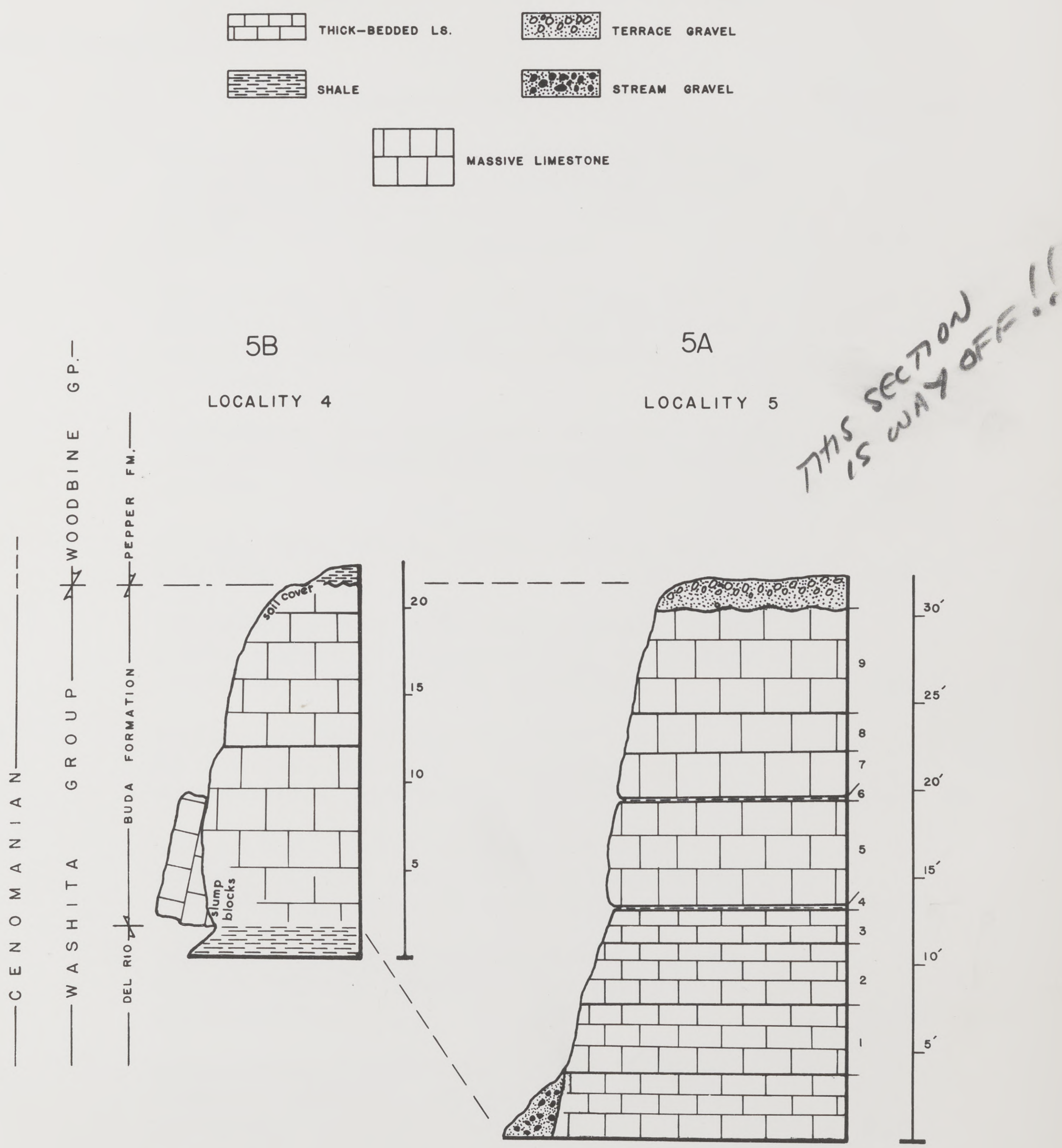



Figure 13.

MEASURED SECTION 5A

Location: Section 5A was measured between Brushy Creek and Highway 79 along a ditch 100 yards from the western boundary (Locality 5, Plate 10).

Buda limestone

| Bed | Description | Thickness (feet) |
|---|---|---|
| 9 | Limestone, light yellow brown, hard, massive, slightly glauconitic, contains echinoid spines, colonial corals, and Pecten roemeri. | 5.9 |
| 8 | Limestone, light yellow brown, hard, massive, crystalline, slightly glauconitic, honey-combed, contains oolites. | 2.3 |
| 7 | Limestone, tan with red streaks, hard, massive, glauconitic, slightly honeycombed. | 2.6 |
| 6 | Shale, tan, soft, thin-bedded, arenaceous. | 0.2 |
| 5 | Limestone, tan with red streaks, massive, slightly glauconitic, contains leached large fossil imprints. | 6.0 |
| 4 | Shale, light brown to white, soft, laminated, fissile, friable, arenaceous, granular. | 0.3 |
| 3 | Limestone, white to light yellow brown, pepper speckled, medium hard, thin-bedded, fossil detrital. | 2.1 |
| 2 | Limestone, light yellow brown, hard, thick-bedded, nodular, slightly glauconitic. | 3.6 |
| 1 | Limestone, light tan, hard, thick-bedded, nodular, slightly glauconitic. | 3.9 |
| | Total Buda measured | 26.9 |
| | Total section measured | 26.9 |

MISMEASURED

# MEASURED SECTION 6

LOCALITY 6

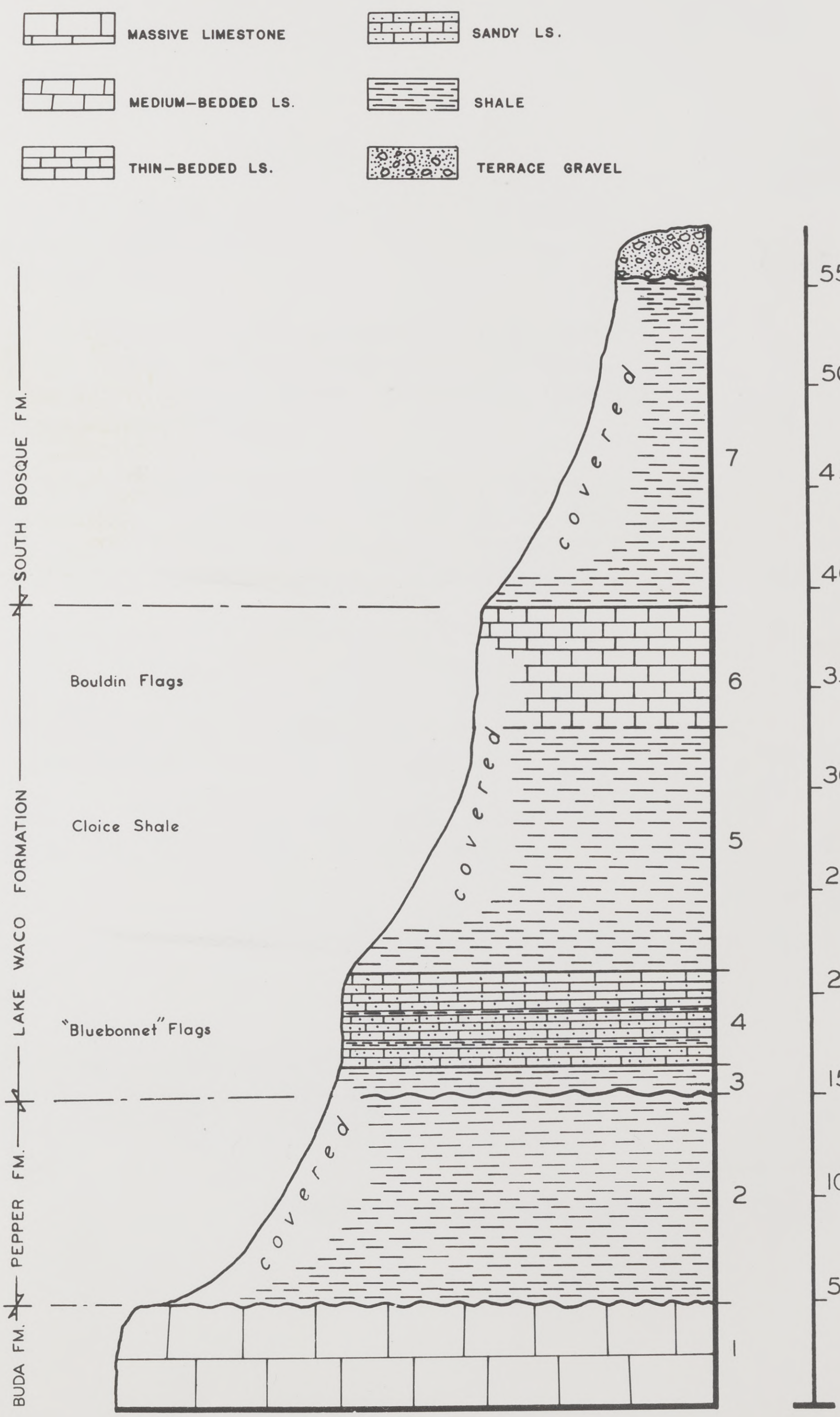



Figure 14.

## MEASURED SECTION 6

Location: Section 6 was measured along the gravel road that crosses Rabbit Hill near the northeastern corner of Brushy Creek Quadrangle (Locality 5, Plate 10).

Eagle Ford shale

| Bed | Description | Thickness (feet) |
|---|---|---|
| 7 | Shale, light yellow brown to dark gray, soft, fissile, laminated, (covered). | 16.0 |
| 6 | Limestone, light greenish gray to tan, hard, medium and thin-bedded, weathers into flags, contains fossil wood, (covered). | 6.0 |
| 5 | Shale, light brown to gray, soft, fissile, laminated, contains a few thin stringers of sandy limestone 9 feet from the base, (covered). | 12.0 |
| 4 | Limestone, light greenish gray to light brown, hard, thin-bedded, flaggy, very arenaceous, contains bentonite stringers, and rarely <u>Inoceramus</u> sp. and <u>Ostrea</u> sp. | 4.6 |
| 3 | Shale, light brown, soft, fissile, plastic when wet, laminated. | 1.6 |
| | Total Eagle Ford measured | 40.2 |

Pepper shale

| Bed | Description | Thickness (feet) |
|---|---|---|
| 2 | Shale, light brown to dark gray, soft, plastic when wet, laminated, gypsiferous, (covered). | 10.0 |
| | Total Pepper measured | 10.0 |

Buda limestone

| Bed | Description | Thickness (feet) |
|---|---|---|
| 1 | Limestone, light brown to tan, hard, massive, glauconitic, fossiliferous, honey-combed. | 4.9 |
| | Total Buda measured | 4.9 |
| | Total section measured | 55.1 |

# MEASURED SECTION 7

## LOCALITY 7

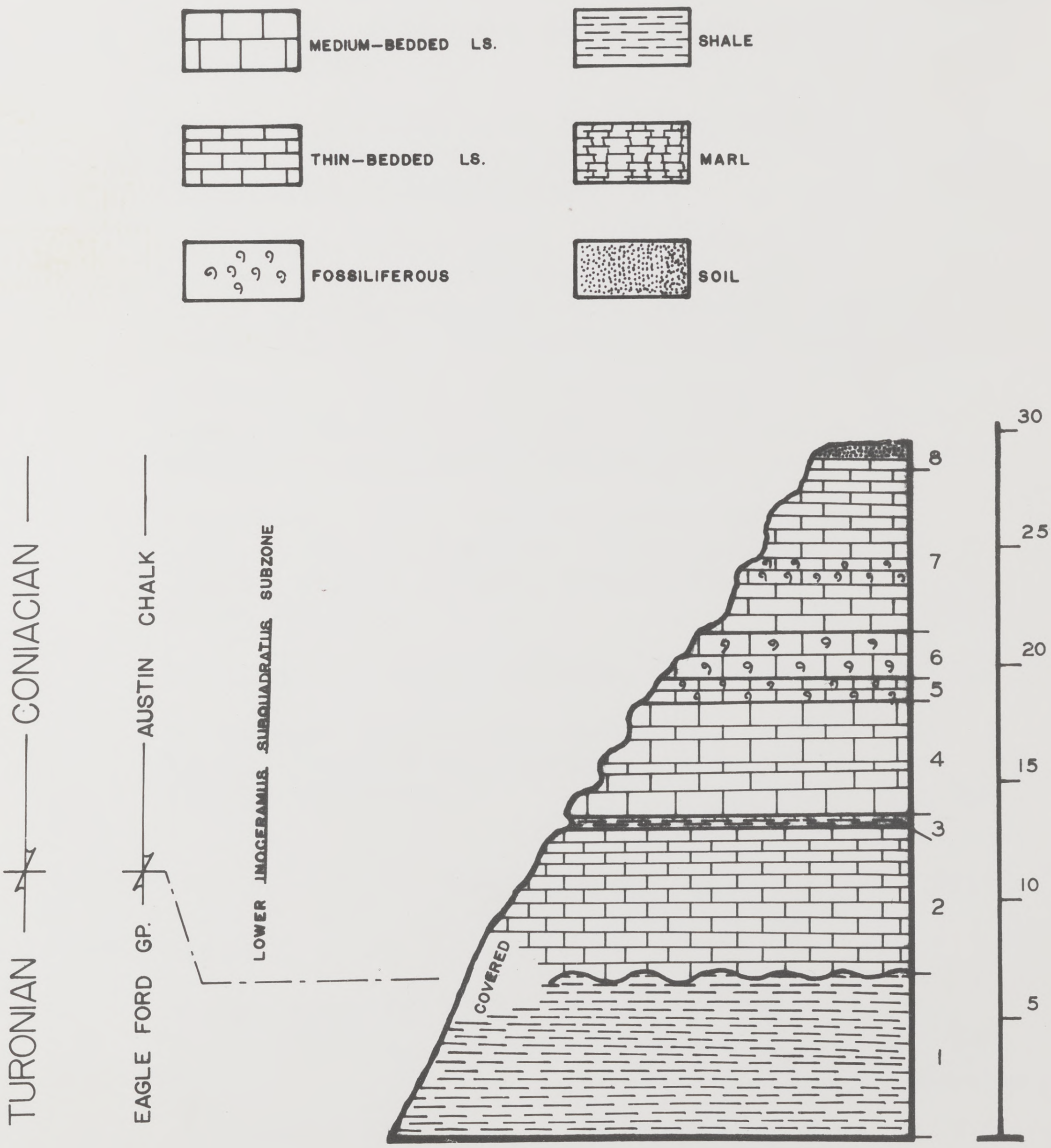



Figure 15.

MEASURED SECTION 7

Location: Section 7 is exposed on Lawson Farm in the extreme northeastern corner of Brushy Creek Quadrangle (Locality 7, Plate 10).

Austin chalk

| Bed | Description | Thickness (feet) |
|---|---|---|
| 8 | Same as 7, with some small folds or undulations. | 1.1 |
| 7 | Limestone, light gray to white, soft, thin-bedded, chalky, contains <u>Inoceramus subquadratus</u>. | 6.3 |
| 6 | Limestone, light gray, medium hard, medium-bedded, nodular, chalky, contains <u>Peroniceras</u> sp. aff. <u>westphalicum</u>, <u>Scaphites</u> sp., <u>Inoceramus subquadratus</u>. | 1.9 |
| 5 | Limestone, light gray to light tan, soft, thin-bedded, chalky, contains numerous <u>Inoceramus subquadratus</u>. | 1.0 |
| 4 | Limestone, light tan to white, weathers gray, thin-bedded with three medium-bedded slight ledges, marcasite spherules, chalky. | 5.8 |
| 3 | Marl, gray, soft, friable, laminated. | 0.6 |
| 2 | Limestone, light gray to white, medium hard, thin-bedded, chalky, contains shell fragments. | 5.0 |
| | Total Austin measured | 21.7 |

Eagle Ford shale

| Bed | Description | Thickness (feet) |
|---|---|---|
| 1 | Shale, gray to light yellow brown, soft, fissile, caliche nodules. | 7.0 |
| | Total Eagle Ford shale measured | 7.0 |
| | Total section measured | 28.7 |

# MEASURED SECTION 8

LOCALITY II

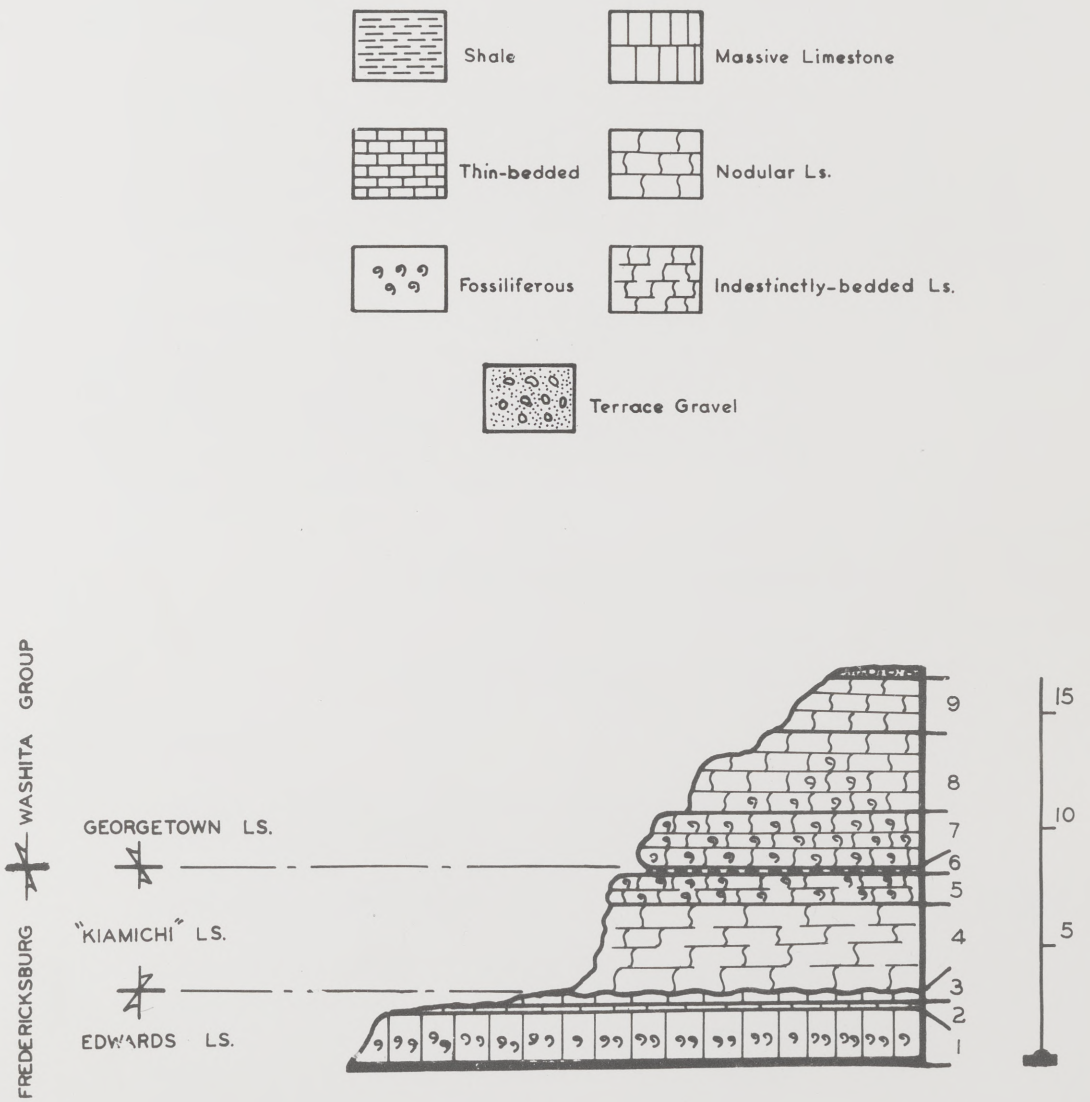



Figure 16.

## MEASURED SECTION 8

Location: Section 8 was measured at the railroad bridge over Lake Creek in Round Rock (Locality 11, Plate 10).

Georgetown limestone

Member A

| Bed | Description | Thickness (feet) |
|---|---|---|
| 9 | Limestone, light gray to tan, hard, medium-bedded, nodular. | 2.5 |
| 8 | Limestone, light gray to tan, hard, medium-bedded, nodular, contains Gryphaea washitaensis and one individual of Elobiceras sp. was found 4.8 feet above the base of the Georgetown. | 3.4 |
| 7 | Limestone, light gray to tan, hard, massive, nodular, contains numerous Gryphaea washitaensis, and one individual of "Eopervinquieria" n. sp. 2 (?) (UT, 10544) was found at the top of this bed. | 2.2 |
| | Total Member A measured | 8.1 |
| | Total Georgetown measured | 8.1 |

"Kiamichi" limestone

| Bed | Description | Thickness (feet) |
|---|---|---|
| 6 | Shale, light gray to tan, slightly indurated, friable, very thin-bedded, arenaceous, calcareous, fossiliferous, contains Gryphaea sp. | 0.3 |
| 5 | Limestone, light gray to tan, hard, thick-bedded, nodular, arenaceous, pyritic, contains Gryphaea sp., one Oxytropidoceras sp. aff. belknapi collected from the base of this bed. | 1.2 |

| Bed | Description | Thickness (feet) |
|---|---|---|
| 4 | Limestone, light gray to tan, hard, medium to thin-bedded, nodular, arenaceous, pyritic, contains numerous <u>Gryphaea</u> sp. and <u>Pecten</u> sp., one individual of "<u>Eopervinquieria</u>" n. sp. 1 (Plate 1) collected 1.9 feet over Edwards limestone, imprint of <u>Oxytropidoceras</u> sp. (fine-ribbed) 0.5 foot over Edwards. | 3.8 |
| | Total "Kiamichi" measured | 5.3 |
| Edwards limestone | | |
| 3 | Limestone, white to light tan and gray, hard, microcrystalline, scattered <u>Toucasia</u>. | 0.4 |
| 2 | Shale, light gray to tan, slightly indurated, very thin-bedded, friable, fissile, argillaceous. | 0.3 |
| 1 | Limestone, white, hard, massive, rudistid and caprinid biostrome. | 2.0 |
| | Total Edwards measured | 2.7 |
| | Total section measured | 16.1 |

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Explanation of Plate 1

Figure 1, Elobiceras sp., X 3/4, Member A of the Georgetown limestone, Lake Creek at railroad bridge in Round Rock. Measured section 8, bed 8, Locality 11. (UT, 10529).

Figure 2, "Eopervinquieria" n. sp. 1 (this paper), X 3/4, "Kiamichi" limestone. Measured section 8, bed 4, Locality 11. (UT, 10530).

Figure 3, Engonoceras sp., X 1, Comanche Peak limestone, 300 paces downstream from the junction of the North and Middle San Gabriel Rivers northwest of Georgetown. (UT, 10527).

Plate 1.

Explanation of Plate 2

Figure 1, _Mortoniceras_ n. sp. 1 (Arrington) aff. _trinodosum_ (Böse), X 1/2, Member B of the Georgetown limestone. One mile northwest of Highway 81 and Highway 195 junction in Berry Creek Quadrangle. (UT, 10107).

Figure 2, _Mortoniceras_ n. sp. 2 (Arrington) aff. _trinodosum_ (Böse), X 1/2, Member B of the Georgetown limestone. Berry Creek 0.4 mile west of Highway 81 and Highway 195 junction in Berry Creek Quadrangle. (UT, 10106).

Plate 2.

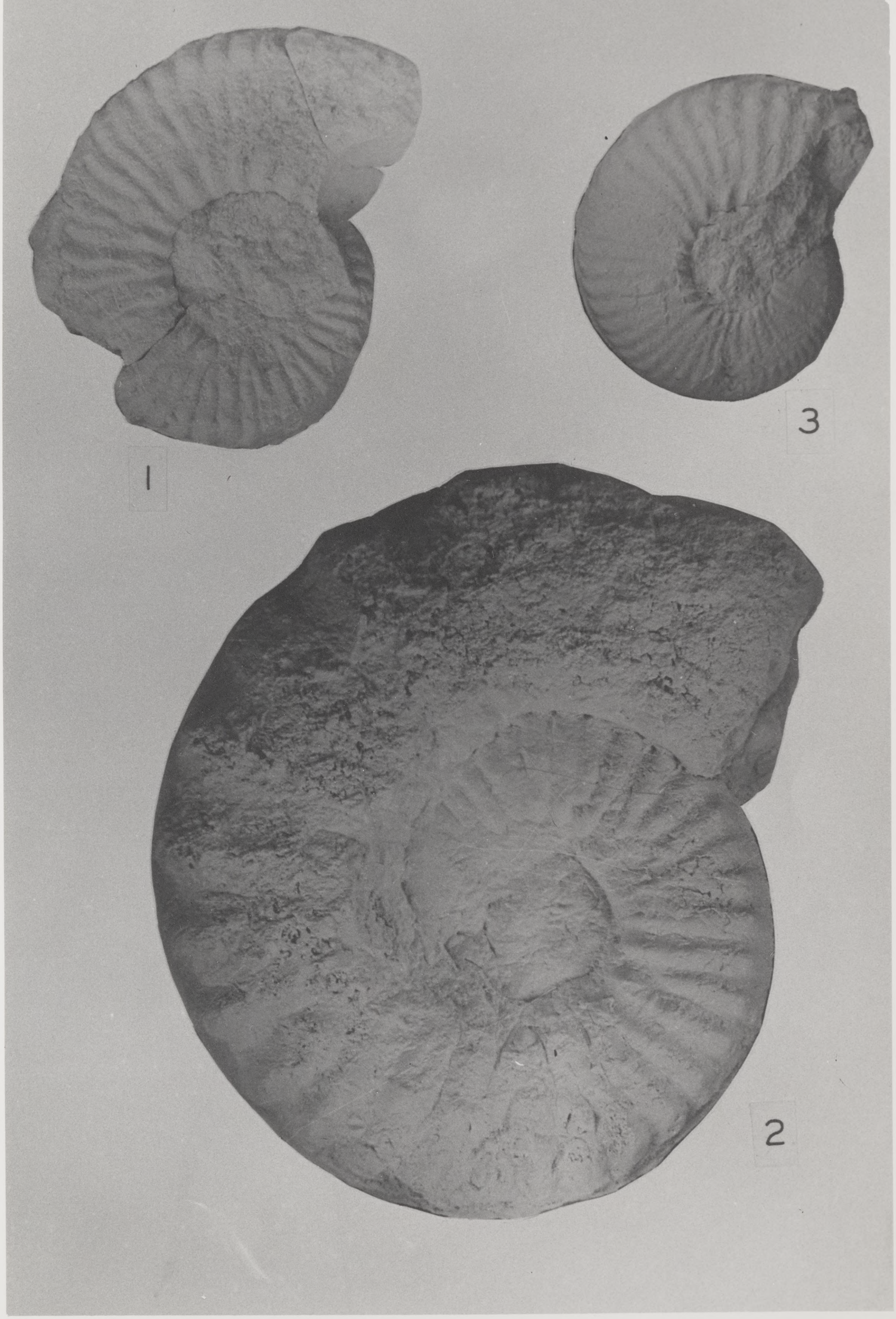
Explanation of Plate 3

Figure 1, Mortoniceras n. sp. 3 (Arrington), juvenile, X 1, approximately 2 feet above the base of Member D of the Georgetown limestone, on Highway 81, 2.7 miles north of Round Rock. (UT, 10526).

Figure 2, Mortoniceras n. sp. 3 (Arrington), X 3/4, Member D of the Georgetown limestone. Measured section 3, bed 7, Locality 3. (UT, 10528).

Figure 3, Mortoniceras n. sp. 4 (Arrington), juvenile, X 1, cf. Prohysteroceras, Member E of Georgetown limestone, 1.1 miles north of Highway 81 and Highway 195 junction in Berry Creek Quadrangle. (UT, 10103).

Plate 3.



Explanation of Plate 4

Figure 1, <u>Mortoniceras</u> n. sp. 4 (Arrington), X 1, approximately 3 feet above the base of Member E of the Georgetown limestone. Locality 10. (UT, 10522).

Figures 2,3, <u>Mortoniceras</u> n. sp. 4 (Arrington), X 1, Member E of the Georgetown limestone, 1.1 miles north of Highway 81 and Highway 195 junction in Berry Creek Quadrangle. (UT, 10121).

Plate 4.

Explanation of Plate 5

Figure 1, <u>Leonites</u> n. sp. 1 (Arrington), X 1, 6 feet below the top of Member B of the Georgetown limestone. Locality 10. (UT, 10520).

Plate 5.

Explanation of Plate 6

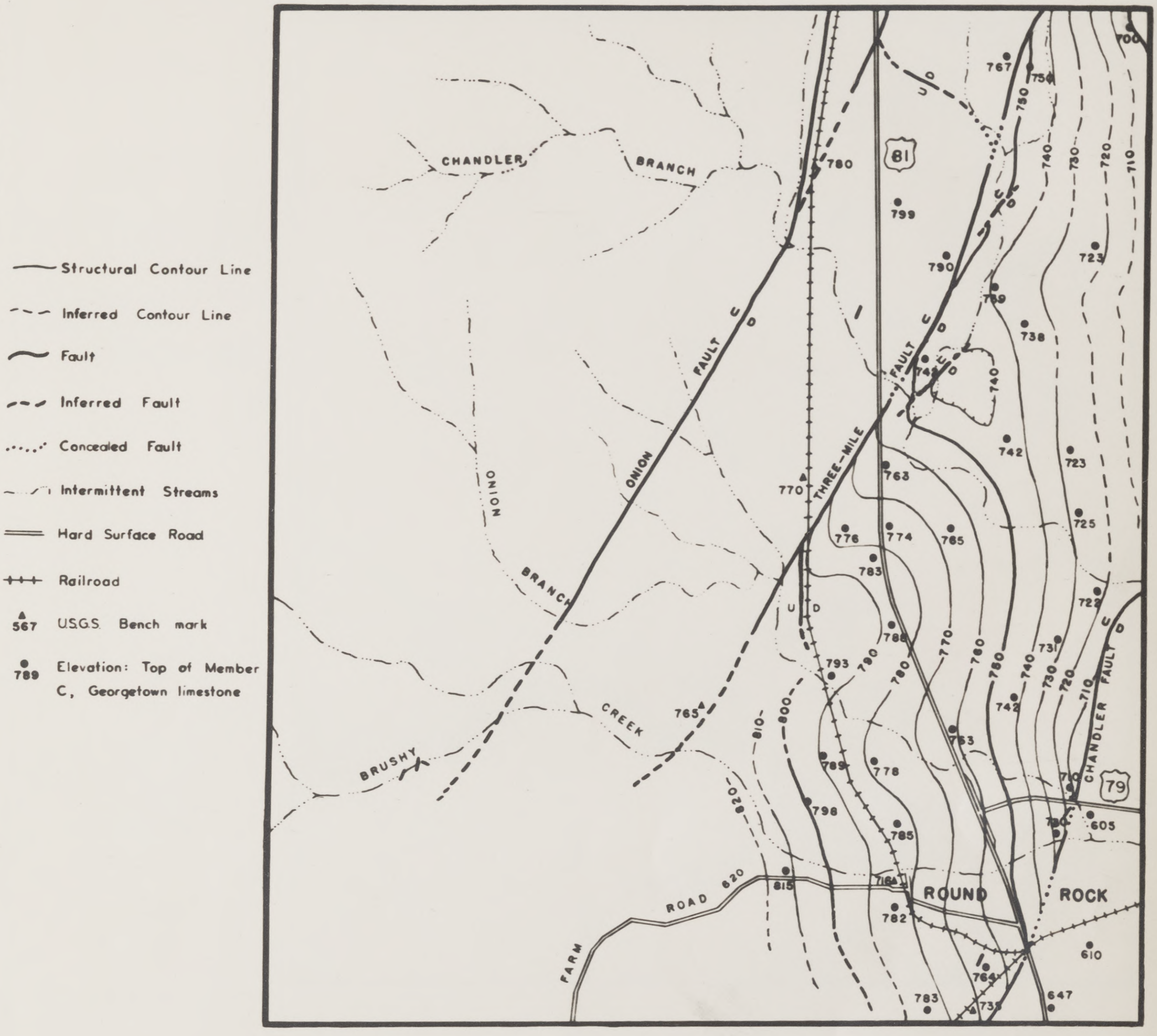
Figure 1, _Leonites_ n. sp. 2 (this paper), X 1, 6 feet below the top of Member B of the Georgetown limestone. Locality 9. (UT, 10523).

Plate 6.

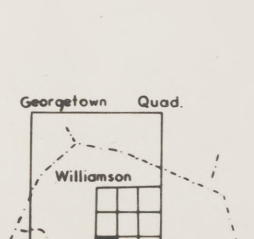
Explanation of Plate 7

Figure 1, Leonites n. sp. 3 (this paper), X 1, 7 feet below the top of Member B of the Georgetown limestone. Locality 10. (UT, 10521).

Plate 7.




# GEOLOGY OF BRUSHY CREEK QUADRANGLE, WILLIAMSON COUNTY, TEXAS




## PRELIMINARY STRUCTURAL CONTOUR MAP

**TOP: MEMBER C, GEORGETOWN LIMESTONE**

BY DICK E. ATCHISON

SUPERVISED BY: KEITH YOUNG
UNIVERSITY OF TEXAS

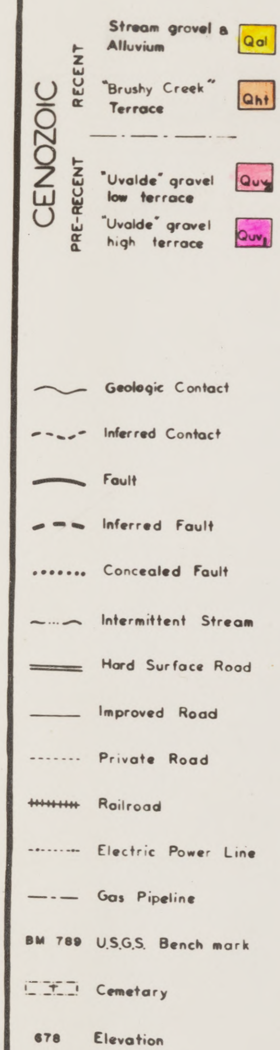
1 0.5 0 0.5 1
MILES

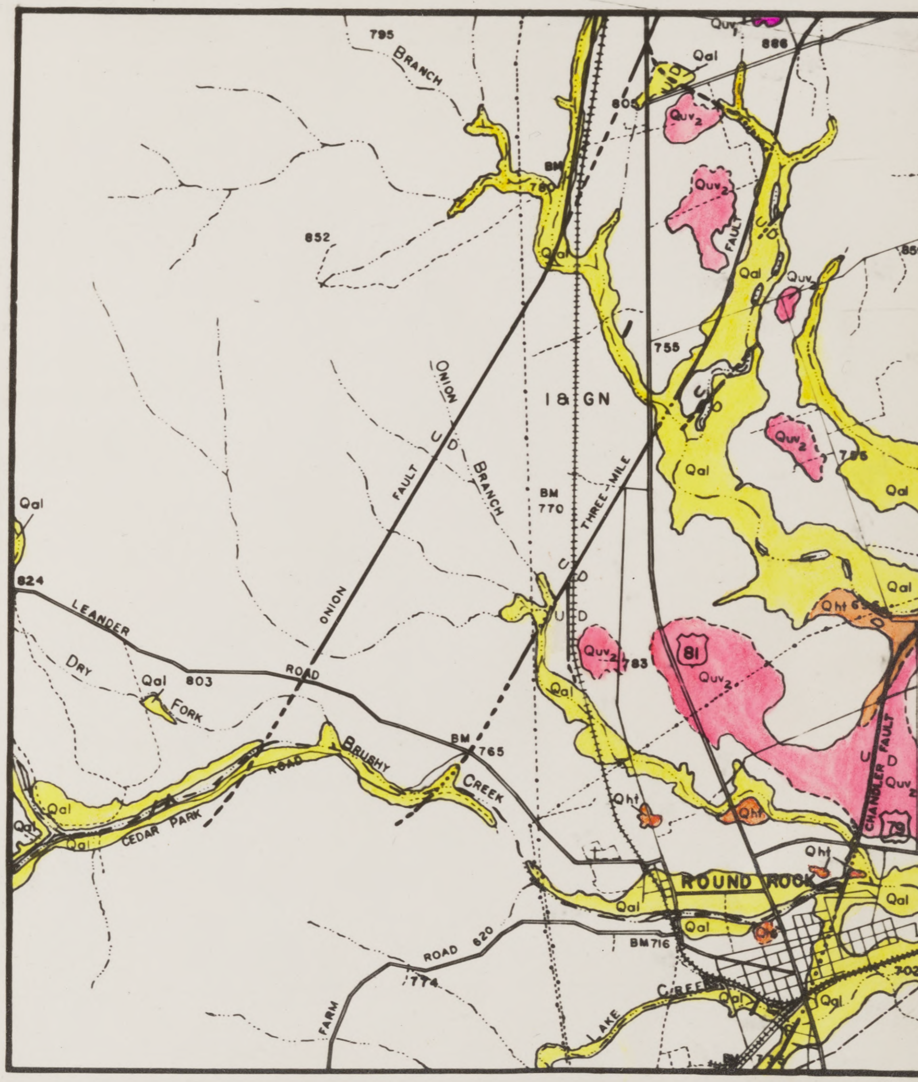
North
True
Magnetic
9.5°

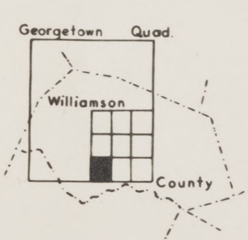
BASE: USGS Topographic Map
Round Rock Quad. 1925 revised 1949

Approximate Mean Declination: 1925

PLATE 8.



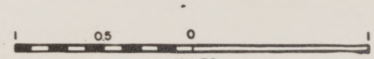



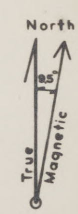

# GEOLOGY OF BRUSHY CREEK QUADRANGLE, WILLIAMSON COUNTY, TEXAS

## CENOZOIC SEDIMENTS

BY DICK E. ATCHISON

SUPERVISED BY: DR. KEITH YOUNG
UNIVERSITY OF TEXAS



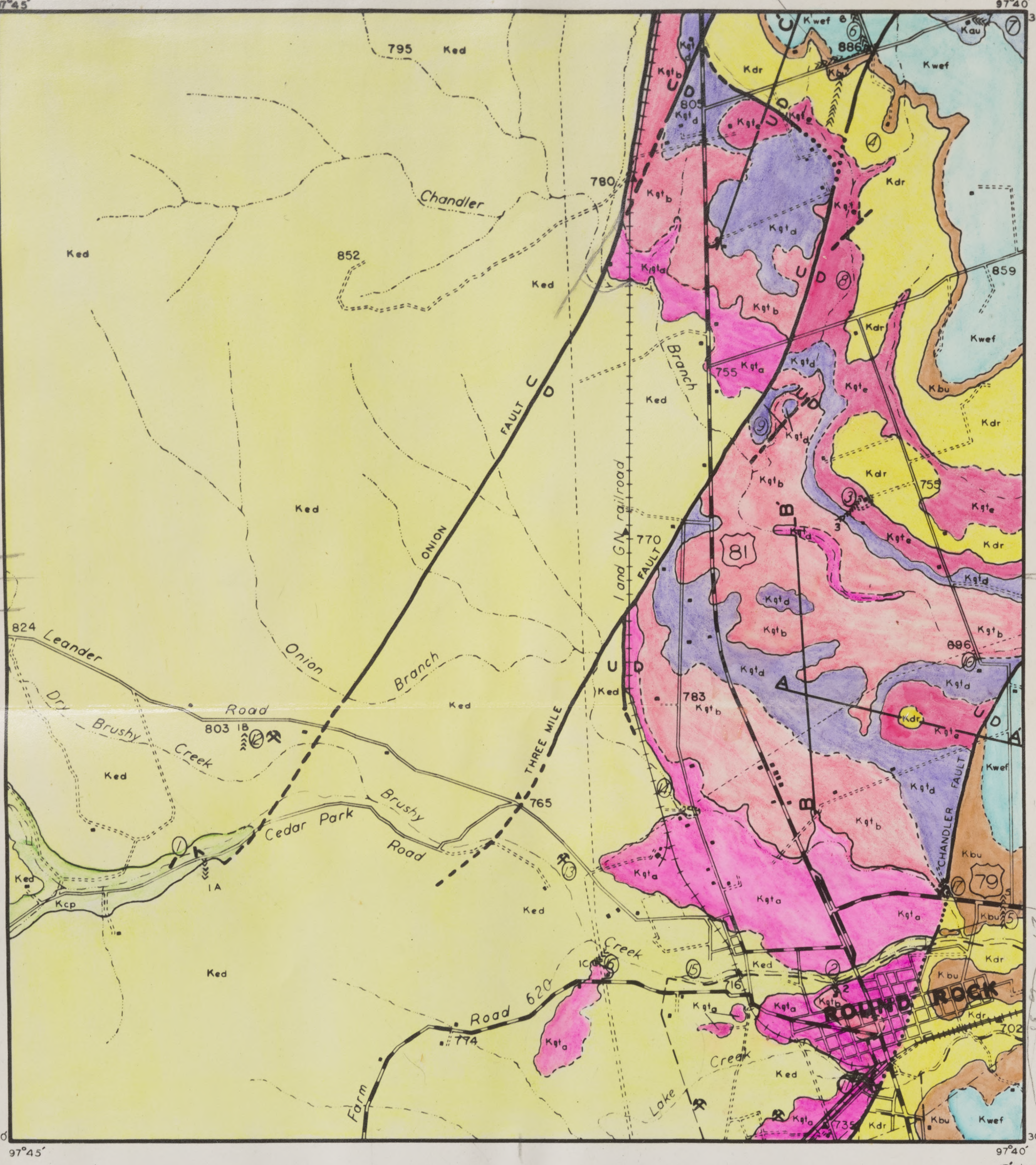



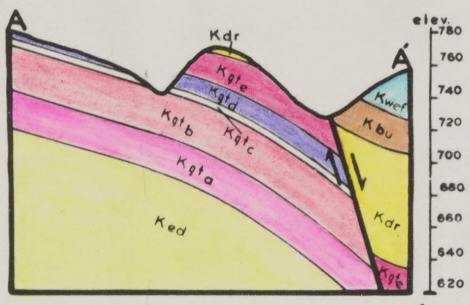

Field Work: July 1953 April 1954
Map Printed: May 1954

Base: USGS Topographic Map
Round Rock Quadrangle 1925 (revised 1949)

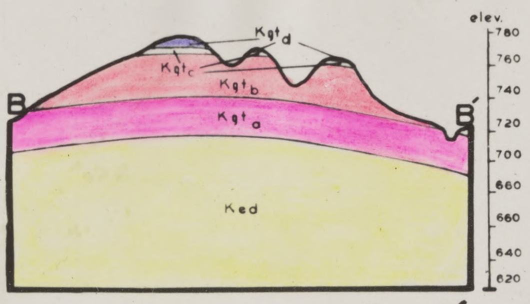
Approximate Mean Declination 1925

PLATE 9.

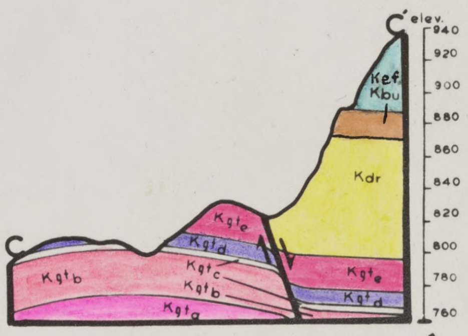


cross section along line A—A′



cross section along line B—B′



cross section along line C—C′

# GEOLOGY OF BRUSHY CREEK QUADRANGLE, WILLIAMSON COUNTY, TEXAS

# BEDROCK MAP

BY DICK E. ATCHISON

SUPERVISED BY DR. KEITH YOUNG

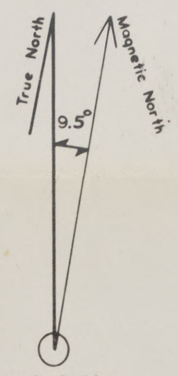
UNIVERSITY OF TEXAS

FIELD WORK: JULY 1953 - APRIL 1954 MAP PRINTED: MAY 1954

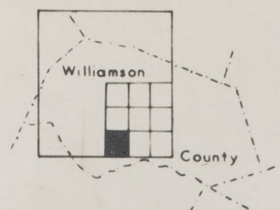
1 0.5 0 1

MILES

| | | | | |
|---|---|---|---|---|
| UPPER CRETACEOUS | CONIACIAN | AUSTIN CHALK | Kau | *Inoceramus subquadratus* Zone |
| | TURONIAN | WOODBINE AND EAGLE FORD GROUPS | Kwef | |
| | CENOMANIAN | BUDA LIMESTONE | Kbu | |
| | | DEL RIO CLAY | Kdr | |
| LOWER CRETACEOUS | ALBIAN | GEORGETOWN LIMESTONE | Kgte | Member E |
| | | | Kgtd | Member D |
| | | | | Member C |
| | | | Kgtb | Member B |
| | | | Kgta | Member A |
| | | EDWARDS LIMESTONE | Ked | |
| | | COMANCHE PEAK LS | Kcp | |



Approximate Mean Declination, 1925




Geologic contact
Inferred contact
Fault
Inferred fault
Concealed fault
Hard surface road
Improved road
Private road
Railroad
Electric power line
Gas pipeline
City boundary line
Measured section
▲ 875 U.S.G.S. Bench mark
Cemetery
Locality
House, Church, School

Base: U.S.G.S. Topographic Map and Edgar Tobin Aerial Surveys Inc Air Photos.

PLATE 10.

# F O S S I L  L I S T

Atchison Thesis

10491 Oxytropidoceras cf. bravoense (Böse)
Comanche Peak Formation, 20 feet below the Edwards, 300 yards downstream from the junction of the north and middle forks of the San Gabriel River, northwest of Georgetown. (Atchison Thesis).

10492 Engonoceras sp. Same as 10491.

10493 Engonoceras sp. Same as 10491.

10494 Enallaster sp. Same as 10491.

10495 Metengonoceras aff. hilli (Bohm)
Walnut formation, Gryphaea reef at the first crossing of North San Gabriel road and North San Gabriel River northwest of Georgetown. (Atchison Thesis).

10496 Exogyra texana (Roemer). Same as 10495.

10497 Gryphaea mucronata (Gabb). Same as 10495.

10498 Metengonoceras aff. hilli (Bohm). Same as 10495.

10499 Enallaster sp. Same as 10495.

10500 Holectypus planatus (Roemer)
Edwards formation, abandoned quarry 1/2 mile east of Round Rock on Brushy Creek. (Locality 15, Atchison Thesis).

10501 Enallaster sp. Same as 10500.

10502 Holectypus planatus (Roemer). Same as 10500.

10503 Enallaster sp.
"Kiamichi" formation, north bank of Lake Creek under the railroad bridge in Round Rock. (Locality 11, Atchison Thesis).

10504 Exogyra cf. texana (Roemer)
"Kiamichi" formation, 40 paces upstream from the U.S. Highway 81 bridge over Brushy Creek at Round Rock. (Near Locality 2, Atchison Thesis).

10505 <u>Oxytropidoceras</u> <u>belknapi</u> (Marcou)
"Kiamichi" formation, 100 paces downstream from the U.S. Highway 81 bridge over Brushy Creek at Round Rock. From under side of a ledge. (Near Locality 2, Atchison Thesis).

10506 <u>Oxytropidoceras</u> <u>belknapi</u> (Marcou)
"Kiamichi" formation, 1/2 mile downstream from RR bridge, and 1/4 mile upstream from the Old Round Rock road crossing of Onion Creek. (Locality 14, Atchison Thesis).

10507 <u>Oxytropidoceras</u> cf. <u>supani</u> (Lasswitz). Same as 10506.

10508 <u>Desmoceras</u> <u>brazoense</u> (Shumard)
Georgetown formation Member A, 1/4 mile downstream from the U.S. Highway 81 bridge over the South San Gabriel River in Georgetown. (Atchison Thesis).

10509 <u>Idiohamites</u> <u>fremonti</u> (Marcou)
Georgetown formation Member A, 6 feet above "Kiamichi" in same location as 10505. (Atchison Thesis).

10510 <u>Mortoniceras</u> sp. 2 specimens.
Georgetown formation Member A, Railroad cut across the McNeil road from the Lime Company southwest of Round Rock about 1/2 mile. (Atchison Thesis).

10511 <u>Idiohamites</u> <u>fremonti</u> (Marcou)
Georgetown formation Member A, 60 paces east of the railroad and 100 paces up the small branch joining Lake Creek in Round Rock. Imprints of 16 ammonites were seen in this small area of outcrop. (Atchison Thesis).

10512 <u>Mortoniceras</u> n. sp. 2 (Arrington) aff. <u>trinodosus</u> (Böse).
Georgetown formation Member A. Same as 10510. (Atchison Thesis).

10513 <u>Mortoniceras</u> n. sp. 1 (Arrington) aff. <u>trinodosus</u> (Böse).
Georgetown formation Member A, 8 feet above 10508 at same location. (Atchison Thesis).

10514 <u>Mortoniceras</u> n. sp. aff. <u>trinodosus</u> (Böse).
Georgetown formation Member A, San Gabriel River about 1 mile downstream from the railroad bridge east of Georgetown. Bell Gin Quad. mapped by Billy Walls.

10515 *Leonites* n. sp. 1 (Arrington) juvenile
Georgetown formation Member B, abandoned road ballast pit 200 paces east of U.S. Highway 81 bridge over Chandler Branch approximately 4 miles north of Round Rock. Just south of Smith's farmhouse. (Locality 9, Atchison Thesis).

10516 *Leonites* n. sp. 1 (Arrington) juvenile
Georgetown formation Member B, from tank on McAdams Farm 1/2 mile east of U.S. Highway 81, 1 mile north of Round Rock. County road crosses Chandler Branch. (Locality 10, Atchison Thesis).

10517 *Leonites* n. sp. 1 (Arrington)
Georgetown formation Member B. Same as 10516.

10518 *Prohysteroceras austinense* (Roemer)
Georgetown formation Member B, in Chandler Branch at same location as 10516.

10519 *Mortoniceras* (*Leonites*) *maximum* (Lasswitz)
Georgetown formation Member A. Same as 10514.

10520 *Leonites* n. sp. 1 (Arrington), 6 feet below top of Georgetown formation Member B. Same as 10516.

10521 *Leonites* n. sp. 3
Georgetown formation Member B, 7 feet below base of Member C. Same as 10516. (Atchison Thesis).

10522 *Mortoniceras* n. sp. 4 (Arrington)
Georgetown formation Member E. 300 paces west up the hill slope toward the Del Rio outlier. (Atchison Thesis).

10523 *Leonites* n. sp. 2
Georgetown formation Member B, 6 feet below Member C contact. (Locality 9, Atchison Thesis).

10524 *Leonites* sp. juvenile
Georgetown formation Member B. Same tank as 10516.

10525 *Mortoniceras* n. sp. 1 aff. trinodosus (Böse) (Arrington Thesis). Georgetown formation Member A. Same as 10513.

10526 *Mortoniceras* n. sp. 3 (Arrington)
Georgetown formation Member D, top of the first small hill south of the Chandler Creek-U.S. Highway crossing on 81, 2.7 miles north of Round Rock. (Atchison Thesis).

10527 Engonoceras sp. Same as 10491.

10528 Mortoniceras n. sp. 3 (Arrington)
Georgetown formation Member D, 1/2 mile east of Highway 81, 2 miles north of Round Rock. (Measured section 3, Locality 3, Atchison Thesis).

10529 Elobiceras sp.
Georgetown formation Member A. (Measured section 8, bed 8, Locality 11, Atchison Thesis).

10530 "Eopervinquieria" n. sp. 1
"Kiamichi" formation, (Measured section 8, bed 4, Locality 11, Atchison Thesis).

10531 Leonites sp.
Georgetown formation Member B, North Georgetown south of the Rivers, cut bank south of city gravel pit. (Atchison Thesis).

10532 Leonites sp. juvenile
Georgetown formation Member B, same location as 10516.

10533 Exogyra clarki (Shattuck)
Buda formation, north bank of Brushy Creek, 300 paces downstream from the dam at Round Rock. (Atchison Thesis).

10534 Enallaster sp.
Buda formation, same as 10533.

10535 Gryphaea graysonana (Stanten)
Del Rio formation, lower part, Hawkins Farm about 3 miles north of Round Rock and 1 mile east of Highway 81. (Locality 4, Atchison Thesis).

10536 Budaiceras sp.
Float, same location as 10535.

10537 Pyritic micromorphs collected from same location as 10535. Exogyra arietina, Turrilites bosquensis, and others. (Atchison Thesis).

10538 Mortoniceras n. sp. 4 (Arrington Thesis).
Georgetown formation Member E, same as 10521.

10539 Hamatid
Georgetown formation Member E, same as 10521.

10540 <u>Hemiaster elegans</u>
Georgetown Member B. Locality 3, same as 10528.

10541 <u>Mortoniceras</u> n. sp. 2
Georgetown Member A, north bank of Brushy Creek at dam in east Round Rock.

10542 <u>Idiohamites fremonti</u>. Georgetown Member A. (Locality 9, Atchison Thesis)

10543 "<u>Eopervinquieria</u>" n. sp. 2
Georgetown Member A, on Chandler Branch, 1/4 mile upstream from Highway 81 bridge.

10544 Same as 10543.

10545 <u>Budaiceras</u> sp.
Lower Buda, 100 yards downstream from Brushy Creek dam in East Round Rock. (Atchison Thesis).

10546 Ammonite fragment
Float, on Rabbit Hill on Barton Farm. Probably from Bouldin flags. (Atchison Thesis).

10547 <u>Schaphites</u> sp.
Austin chalk. (Measured section 7, bed 6, Locality 7, Atchison Thesis).

10548 <u>Peroniceras</u> sp. aff. <u>westphalicum</u>
Same as 10547.

10549 <u>Oxytropidoceras</u> cf. <u>supani</u>
On Lake Creek, 1/4 mile west of Round Rock White Lime Quarry.

10550 Ammonite fragment
Same as 10547.

10800 <u>Submantelliceras</u> sp.
(Measured section 4, bed 6, Locality 4, Atchison Thesis).

10826 <u>Mortoniceras</u> n. sp. 1 (Arrington) aff. <u>trinodosus</u> (Böse).
Georgetown Member A. Same as UT 10513. (Atchison Thesis).

10827 Mortonicerid
Georgetown Member A. (Measured section 8, bed 7, Locality 11, Atchison Thesis).

10828 *Mortoniceras* n. sp. 2 (Arrington) aff. *trinodosus* (Böse).
Georgetown Member A, 1/4 mile west of Highway 81 and 1/4 mile north of Chandler Branch. (Atchison Thesis).

10829 *Oxytropidoceras* cf. *belknapi*
"Kiamichi" float, Onion Creek. (Locality 14, Atchison Thesis).

10830 *Oxytropidoceras* cf. *supani*
Same as UT 10829.

10831 *Oxytropidoceras* cf. *supani*
Same as UT 10829.

10832 *Oxytropidoceras* cf. *belknapi*
Same as UT 10829.

10833 *Desmoceras brazoense*
Member A of Georgetown, bed of North San Gabriel River, 1/4 mile down stream from Highway 81 bridge at Georgetown.

10834 *Prohysteroceras* cf. *austinensis* juvenile
Member B of Georgetown, Highway 81 cloverleaf in south edge of Belton.

10835 *Leonites maximus*
Georgetown Member B. Same as 10834.

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